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New Gear Cutting Engine.

We present upon this page an engraving and description of a new gear cutter. It is the invention of A. H. Brainard, of the Brainard Milling Machine Co., 36 Oliver Street, Boston, and Hyde Park, Mass.

This machine is the outgrowth of some ten years of careful study and experiment by the inventor.

The general arrangement of the details, together with the form of casting is original. Convenience of handling as well as strength and power has been provided for.

The dividing mechanism is one of the principal characteristics of this machine. Inaccuracies which are liable to occur in the drilling and wear of the holes in index plates, and the wear and loose motion in the teeth of spur gears, are said to have been fully overcome by using a V tooth worm wheel. This wheel is composed of two parts bolted together, making a longitudinal division through its center, and by an improved process of cutting, the teeth in the two halves of dividing wheel are made to exactly coincide in any position. By this process the teeth are brought to such a state of perfection that one-half of the wheel becomes an exact corrector of the other half, and each wheel is finally finished, tested and corrected by the microscope.

The dividing wheel is operated by a steel worm, having bearings provided with every facility for compensating for wear and eliminating every particle of lost motion when it occurs. With these advantages the original accuracy of the machine can be always maintained.

The actuating mechanism of the worm is self-locking, rigidly holding the dividing wheel while the gear tooth is being cut, therefore inequalities, or hard and soft spots in the iron of the gear blank cannot affect the accuracy of the cutting.

Graduated indexes are provided in every place where measurements are necessary.

The cutter can be set by thousandths of an inch to the proper depth without the use of lines or gauges. A simple gauge fixes at a glance the exact center of cutter, in any position of the knee or cutter carriage, while a graduated expanding sleeve sets over the cutter for trimming the sides of bevel gear teeth. The quadrants which support the cutter carriage at any angle are laid out in degrees, with pointer for indicating the angle.

The cutter carriage can be set at angle in either direction, for cutting diagonally or spacing worm wheels.

Connected with the dividing mechanism is a dial, having teeth numbered each side from zero, which can be used as a micrometer for fine divisions or mathematical work, but which is primarily intended for recording the "set over" of bevel gears.

With these various recording appliances it is claimed that the complicated processes of gear cutting are reduced to the simplest and most certain forms, enabling parties to cut their own gears who heretofore have not done so, from want of the theoretical or practical knowledge required.

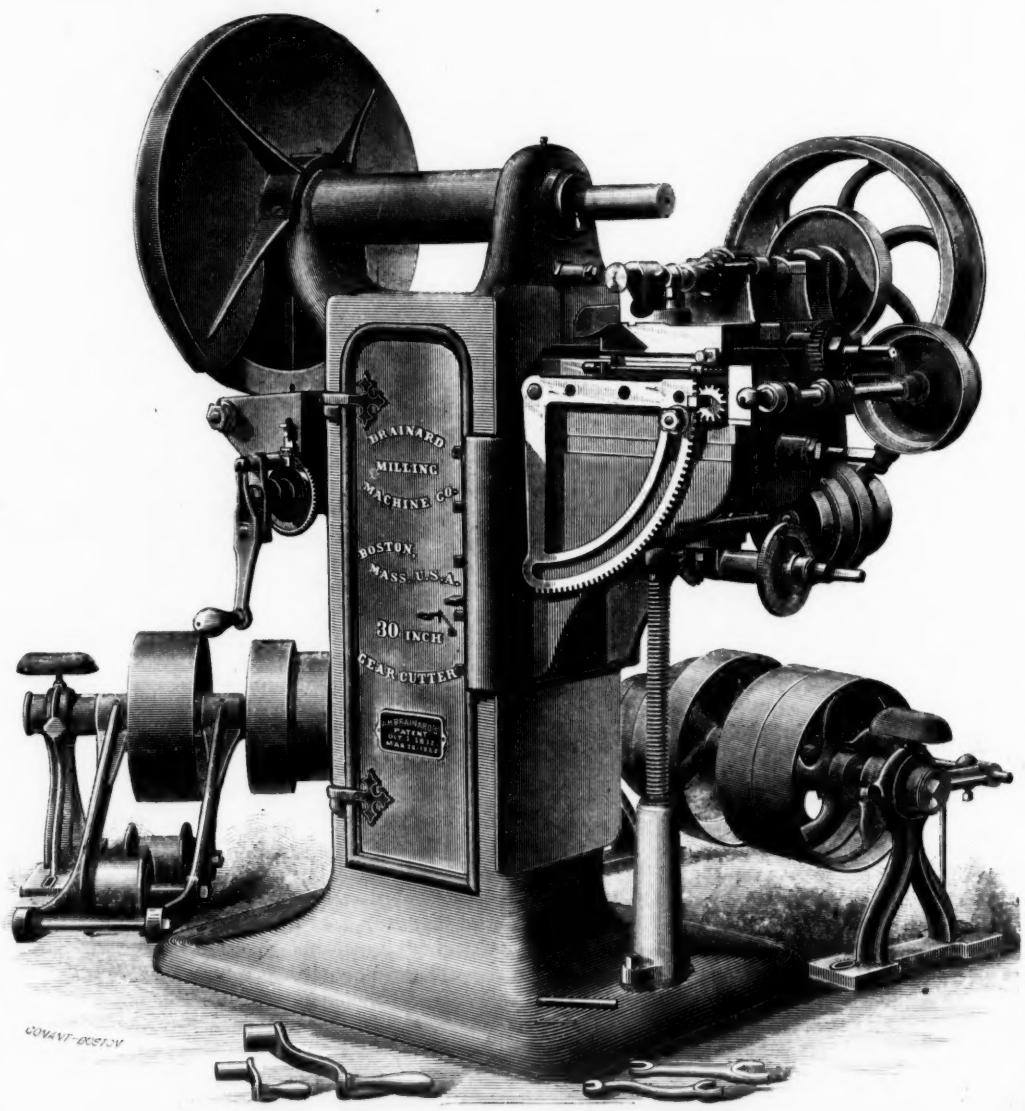
The feed is automatic and has 6 changes, and an adjustable stop dog drops the feed worm at any desired point. The machine can therefore be entrusted to the charge of comparatively unskilled workmen.

All changes when cutting are made by whole turns of the crank, the spring latch having but one seat, the liability to mistakes is therefore very small.

An adjustable rim rest for the blank is provided which effectually prevents chattering, and the working parts are in the strongest position when cutting the largest gears.

The change gears are enclosed in a closet in the machine, with each gear in its separate compartment. The dividing wheel is protected from dust and injury by an iron shield. The spindle, which is made from tool steel, as also the cutter arbor, works in bronze bushings; and the feed worm and worm gear are of hardened tool steel.

The machine weighs 1,800 lbs., will cut spur, bevel, or worm gears to 30 inches diameter and 8 inches face. With the 41 change gears in the closet, the machine divides every number to 100, every even number to 200, including all numbers divisible by 3 or 5, and a large range of higher numbers to one minute of arc, or 21,600. Among the appliances furnished with each machine is a gauge for centering the cutter. The screw for raising and lowering the cutter carriage is located as near the center of gravity as possible, so that there is no tendency to wear the slides out of truth, and insures rigidity.



NEW GEAR CUTTING ENGINE.

Positions of Views upon Mechanical Drawings.

BY OBERLIN SMITH.

A PAPER READ BEFORE THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

A subject well worthy the attention of this Society is the lack of uniformity, and consequent confusion, in the practice of engineers regarding the relative position of the different "views" upon their drawings. It may not be amiss to preface this paper with a brief definition of the nomenclature used herein. We are often told that a mechanical drawing is "a representation of an object upon a plane, as it would appear viewed from an infinite distance." Considering that its appearance under such circumstances would, to speak moderately, be somewhat insignificant, the above definition should be supplemented with the words, "magnified until its size bears a desired ratio to the size of the object itself." This ratio is, of course, known as the *scale*, and is better briefly expressed in the form of a vulgar fraction, as "scale $\frac{1}{8}$," "scale $\frac{1}{2}$," etc., rather than by the clumsy formulas: "scale $1\frac{1}{2}$ inches to the foot," "scale 2 inches to the inch," etc.

The term "drawing" will in general be herein used to designate collectively the delineations of the various desirable views of one object, together with the piece of paper or other material forming the plane of projection. This plane will for convenience be spoken of as "the paper."

The word "view," prefixed by an adjective of direction, will designate each delineation of the object from a given standpoint. This is more systematic, comprehensive and definite than the use of the conventional words "elevation," "transverse section," "plan," "inverted plan," etc., which have not a sufficiently exact meaning. For instance, what idea does "transverse" convey? Who knows which way is *across* or which way is *along* an average house, or drill press, or wagon wheel, or oil cup? In the case of a ship's boom or a shafting lathe it might probably be guessed at with tolerable exactitude.

In fixing our directive adjectives above referred to, let us assume a *front* to the object, and call the six views whose lines of vision are perpendicular to either its frontal or basal planes, or parallel to both, respectively *front* view, *back* view, *left* view, *right* view, *top* view, *bottom* view. Let all other views be termed *oblique* views, and their direction be defined by dotted lines and reference letters upon some of the other views, said dotted lines being the "projections" of their lines of vision: *e. g.*, "oblique view in *a*, *b*, Fig. 1." Let it be understood that the view is always taken *from* the first letter mentioned *toward* the second, as from *a* toward *b*. For *sections* let us use the same names, prefixed by the words "sectional" or "partly sectional," and locate the cutting planes by reference letters upon some other view, placed in their intersections with the plane of the paper; *e g.*, "sectional front view at *c*, *d*, Fig. 2."

Although the name last given is a trifle (three letters) longer than the old wording, "vertical section at *c*, *d*," Fig. 2, it *means* as good deal more. It tells positively upon which side of the cutting plane the view is taken, while the old way leaves it a matter of guesswork.

In assuming a *front* for an object, common sense will usually be sufficiently suggestive, There will be little difficulty in the case of buildings and landscapes. In fixed machines, the side where the operator or attendant is oftenest placed, and toward which he looks, may usually be called the *front*. The *right* and *left* are to his right and left respectively. In machines of locomotion, as animals, boats, vehicles, etc., it would seem necessary to reverse the relative positions of front, right

and left, as the forward going end must be called the front. This need not, however, make confusion if these different sides are marked upon the top view. It is important that when a front for an object is once assumed it should be logically adhered to, not only in all the main views, but in views of any detached parts, which must have their fronts the same as when in their original position in the main view. This same assumed frontage is (to make a digression) also very useful for written and verbal descriptions of locations and motions, as by it can be fixed *directions* as well as positions; *e. g.*, forward, back, left, right, up, down. Thus any point whatever can be located by giving one, two or three of these words, each with a distance suffixed; reference of course being made from some zero point, usually where the basal plane cuts some convenient vertical axis.

It will be noticed that the system above briefly outlined positively identifies all the views upon a drawing, and provides against the expensive mistakes sometimes caused by not interpreting them aright. It should, by the way, be remembered that in all this matter we are dealing with the *reading* of drawings as of more importance than the *making*—just as with any tool; we are more interested in its use and working than in the order of its construction. If we learn how drawings can best be read, the methods of thought easy to the reader will be still easier to the draughtsman. As a matter of ordinary prudence, therefore, to prevent incorrect reading, all views should be marked in plain lettering according to this or some equivalent system. If there were a standard method adopted for the relative position of views, which all draughtsmen practiced, it would, of course, be necessary to mark the primary view only; although on important drawings a full marking would be an additional safeguard. In the present confusion of practice this marking should be done upon all the views of a main drawing. Upon small accompanying detail drawings, especially if of a temporary character, it may be safe to omit it, providing they are to be used in the establishment where made, and also that said establishment uses one uniform method, rather than two or three.

Of the three systems in use one is to place the views upon a drawing wherever there happens to be room; this may be called the mongrel system. The other two are, in the parlance of Descriptive Geometry, known respectively as the "1st angle" and the "3rd angle" systems.

In the complicated methods of the above-mentioned science the object is supposed to have been represented upon certain imaginary planes, which planes are further supposed to have been revolved until coincident with the plane of the paper upon which the drawing is made. For ordinary machinery work, where scarcely ever less than three views (taken from as many different directions) are required, the conventional two planes, intersecting each other at the "ground line," have to be supplemented by auxiliary planes, which, in their turn, have to be imagined as folded down into the plane of the paper. All this brain imagery, often as difficult as playing chess blindfold, though sometimes useful in ascertaining intersections and solving other graphical problems, is usually unnecessary in practical draughting. Happily its use as a tool in teaching pupils to draw is becoming more and more rare in our engineering schools. Good practical draughtsmen are frequently found entirely ignorant of it, and many of those conversant with it hasten to forget.

Discarding then the ordinary methods of Descriptive Geometry, which for reference we will call *A* and *B* respectively, let us see by what simpler means the mind can picture to itself *why* the various views upon a drawing are as they are. Before speaking of the simplest method of all it may be well to refer to two or three that have been proposed.

One (call it *C*) is to imagine the paper to, have been transparent and to have been folded into the form of a parallelopipedon, surrounding the object like a box, and upon the several sides of which the form of the corresponding views of the object may be seen after the paper is straightened out flat again—just as they are when viewed through the box. Another conception (call it *D*) is that the paper has been transparent and has been carried around the object and held up before its several sides successively, the image remaining impressed as before.

The simpler method, previously referred to is to conceive the paper to be what it really is, an opaque flat surface, and the delineation upon it as the object itself, placed in front of the paper. The first position in which it is thus placed we may call the primary view. To obtain a secondary, the object is supposed to be revolved about an axis coincident with the plane of the paper. In some cases it is supposed to be also slid over to a desired position upon a plane parallel with the paper. This latter we will refer to as method *E*, and, for want of a better name, term it "indirect revolution."

The method by "direct revolution" let us, for reference, call *F*.

In analyzing these different methods of mental conception, to ascertain their comparative simplicity, we will assume a *four*-view drawing as being perhaps of average complexity.

In counting the number of conceptions, or mental images, necessary, those calling up the *presence* of the object, its *projection* upon the various planes and its reduction or enlargement to fix the *scale*, may be omitted—being common to all the methods. We then have remaining for method *A* six distinct conceptions, viz., three of the four planes of projection and their three respective revolutions to coincide with the paper. In method *B* we have seven conceptions, six of them are the same as in *A*, and the other is imagining the planes transparent. In method *C* we have the same number—seven. In *D* we have three extra positions for the paper and the transparency, making four in all. In *E* we have three revolutions of the object and three slidings over it—six in all. In *F* there are three movements of the object only. The following table shows the foregoing in brief.

	METHOD.	NO. EXTRA CONCEPTIONS.
A.	First angle of Descriptive Geometry,	6
B.	Third angle of Descriptive Geometry,	7
C.	Transparent box around object,	7
D.	Transparent paper moved about the object,	4
E.	Indirect revolution—revolving and sliding object,	6
F.	Direct revolution of object,	3

A glance at the table shows the great complexity of *A*, *B* and *C*. Method *D* seems simple, but the conception of the paper floating about in the air while it is really lying before one's eyes, is a very difficult one. Method *E* is easier than it looks; the object has been called up in the mind's eye from nowhere, and there is nothing in the idea of its being moved about to give the lie to the visual facts. Method *F* has the same advantages, and the additional one of fifty per cent. less imaginary motions in the object. As said before, they both leave the paper to *seem* exactly what it *is*, a stationary plane. These last two (*E* and *F*) are practically the only methods used by artisans—the chief readers of drawings. We often hear a workman say: "Which way is this thing turned?" He sees the paper, and the picture of the object at which he first happens to look. He sees another view and wonders which way said object was moved, turned and twisted about to present that aspect. If he knows by what system the draughtsman worked he constructs the work aright. If not, he may make it what is technically known as "left-handed" when it should be "right-handed"—or vice versa.

An inspection of the methods above mentioned will show that the resulting disposition of views by methods *B*, *C*, *D* and *E*, is identical—the *top* view appearing *above* the *front* view and the *right* view to its *right*, etc. On the other hand, methods *A* and *F* give each the same result—the top view showing *below* the *front* view and the *right* view to its *left*, etc., Of these two systems the writer personally much prefers the latter—what we have called "direct revolution." It involves to the reader but one conception at a time, and that of the simplest kind.

In connecting a view with another one from which it is derived, he has but to imagine it rolled over (usually through an arc of 90°) on to an adjacent side. It is not uncommon to see a workman aid this mental process by holding a piece of chalk (or any other small object he happens to have in his hand) over one view and roll it on to the next one.

The only advantage of any consequence claimed for the method by indirect revolution is, so far as the writer knows, *shorter* lines of projection in deriving one view from another. This applies especially to long objects, like lathes, etc. The fact is, that such a machine could be but poorly shown by a full right view or left view, placed on either side of the front view. The carriage and one head would be mostly hidden by the other head—the one in the foreground. A sectional right view and a sectional left view (the cutting plane being near the middle of the shears) would much better show the shape of each head, as well as the carriage. In this case the direct-revolution method would require much shorter projecting lines than the indirect.

Which of the two methods of revolution is now used the most, or which will, by natural selection, gain ascendancy until it becomes the standard, it would be difficult to say. A recent correspondence with several prominent engineering establishments develops the fact of an about-evenly divided practice. This line of investigation should be continued, and the feeling of the majority of draughtsman in this country, at least, should be ascertained. This, and a careful study of the merits of the two systems by some competent authority, will probably some time result in the forming of a national standard. To this standard we will doubtless all be ready to conform, regardless of our personal prejudices. The matter is not so important *which* system is used as that there should be a *uniformity* of practice. Meanwhile, all drawings on which each view is not marked in detail should be marked in general, stating by which system made. It is sincerely to be hoped that, in aid of this marking, some shorter and more definite names than the writer has been able to think of may be invented for each of these two systems.

In conclusion, it may be pertinent to suggest that the work foreshadowed in the last paragraph is one among the many tasks to be performed by our hoped-for national engineering commission on experiments and standards. In this commission, should we live to see it, may we find, as a factor in its composition, and not the least one, the American Society of Mechanical Engineers.

In our last issue we accidentally omitted mentioning the following papers presented at the Mechanical Engineers' meeting at Philadelphia:

Heater Performance.—A. F. Nagle. Strength of Wooden Columns.—Prof. G. Lanza. Expansion of Steam and Water without Transfer of Heat.—A. Faber du Faur. An Averaging Machine.—Wm. S. Auchincloss.

Our report of the remarks of Eckley B. Coxe should have begun: "I have been present at many meetings, both of the Civil, Mining and Mechanical Engineers' Societies, at which our dear friend Holley was present."

We devote the greater part of our space this week to papers and discussions of the last meeting of the American Society of Mechanical Engineers. This society is the acknowledged exponent of American progress in mechanical engineering, and the papers read at its meetings and the discussions thereupon will be received by the mechanical public with great interest.

Weight of Fly Wheels.

By Wm. Johnson.

A PAPER READ BEFORE THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

There is evidently a want of definite knowledge among engine builders in regard to the weight of fly wheels, necessary for a given regulation.

This will not appear surprising when we reflect that the question is one—rather of mathematical than mechanical ability. The average engine designer, however great his practical observation and skill, has but little taste or time for solving intricate mathematical problems. He may have clear ideas as to the functional duty of the fly wheel, and know that its regulating power depends upon its weight and velocity. He may even have a fair knowledge of mathematics, without being able to determine, with satisfaction to himself, the correct weight required under specified conditions. He knows that engines will make a certain number of revolutions in a given time, with very light fly wheels, or with enormously heavy ones, and as a man of judgment, he may not verge upon either extreme. Briefly stated, in the great majority of cases in practice, the determination of weight of fly wheel is simply guess work. In fact, it may be questioned whether, even among the more advanced engine builders, two can be found to estimate, approximately, the same weight in a given case. The disagreement would not arise from a want of rules, but in the rules themselves, many of which are either plainly absurd and misleading, or contain constants, the composition of which is best known to the authors.

In the American Machinist of May 29th, 1880, may be found a very interesting and comprehensive article upon the subject of fly wheels, from the pen of Prof. S. W. Robinson of the Ohio State University. The article has a practical bearing, and will well repay a careful reading. In the analysis presented we have a clear physical conception of fly-wheel requirement. Fluctuation is fully described, and its coefficient shown to be an important factor in the problem of weight. The acceleration of the fly wheel is there compared with that of falling bodies. It is shown that an excess in foot pounds during one stroke is equal to the work of the stroke, multiplied by the ratio of excess to mean rotative effect. The special object of this paper is to direct attention to the deductions of the article referred to, as the basis for a plain, practical rule among engineers for computing the proper weight of fly wheels, which we believe to be both desirable and necessary. The rule should be simple and easily understood, as well as correct in its result, and should contain only such numbers or terms as harmonize with a proper conception of the problem. The following rule is believed to meet the requirement and may be stated thus:

The weight of wheel is equal to the continued product of the area of the piston in square inches; boiler pressure by gauge in pounds; stroke of engine in feet; value for cut off; coefficient of fluctuation, and accelerating force of gravity, divided by the square of the velocity in feet per second of the center of gyration of the wheel.

The value for cut off, as given by Professor Robinson, may be taken as ranging from 0.16 to 0.22, and the coefficeint of fluctuation at from 20 to 60, according to the degree of regulation required. One example will serve as an illustration. Take an engine with a cylinder 18″×36″; pressure, 80 pounds; cut off at half stroke; fluctuation, 40; diameter of wheel, 10 feet; number of revolutions, 100; and assuming the center of gyration at a distance from center of wheel of four-fifths the radius. Avoiding fractions, we have

$$\frac{254\times80\times3\times0.18\times40\times32}{1754}=8{,}000$$

pounds weight of wheel.

Take the same example, but with half the number of revolutions, and we have as our divisor $\frac{1754}{4}=438\frac{1}{2}$, and the weight of wheel 32,000 pounds.

Again, take the same example, but increase the speed to 150 revolutions, and the divisor becomes $1764 \times 2.25 = 3946$ or 3550 pounds, as the weight of wheel. If now we take the same example, but change the coefficient to 20, we shall find the weight of wheel reduced one-half, from which we learn that, while the weight is inversely as the square of the velocity, it is directly as the coefficient of fluctuation.

In conclusion, it will be seen from the example that the regulating power for the weights determined remains constant with a given fluctuation, without regard to the time in which the fluctuation occurs.

Extracts from Chordal's Letters.

A PLATE-IRON CHIMNEY.

Mr. Editor:

* * * * As promised in my last letter, I send you herewith a drawing of a plate-iron chimney. It will be a novelty to many; for, though there are thousands of these chimneys in this country, they are still a rarity. I think we will see more of them in course of time.

For the drawings from which this sketch is made, I am indebted to Messrs. Witherow & Gordon, of Pittsburgh, Pennsylvania, who have erected great numbers of these chimneys.

* * * * The drawing sets forth a proportion not attainable in brick or thin iron, and I therefore assume that the appearance, as well as the construction of these chimneys will be new to most of your readers.

It should be borne in mind that this drawing is to scale from actual sizes, and that as a consequence the tapering effect due to perspective is somewhat lost. It is very much like a drawing of a railroad track; that is, it is as the thing really is, and not as it looks.

* * * * I will state that this is what Messrs. Witherow & Gordon call one of their small chimneys.

Instead of putting figures on the drawing, I prefer to specify the dimensions here.

The heights are:

Ground to top	175 feet.
Ground to top of base curve	18 "
Top to nose of bell	4 "
Top to arc of bead	13 ft. 9 in.

Diameters are:

Shell at top	6 ft. 10 in.
Shell at top of base curve	8 ft. 6 in.
Base of shell	15 feet.

The size of mouldings are:

Radius of top head	15 inches.
Radius of bell nose	30 "

The thicknesses are:

The base curve, 18 feet, is of $\frac{3}{8}$ in. iron.
Then 40 feet of $\frac{5}{16}$ in. iron.
Then 40 feet of $\frac{1}{4}$ in. iron.
Then 40 feet of $\frac{3}{16}$ in. iron.
Then balance of $\frac{5}{32}$ in. iron.
The top mouldings are No. 12 iron.

The main body is in courses of iron four feet wide. The base curve is of longitudinal strips, some with top mouldings.

The curved base is riveted to a cast iron ring of tee section, the ring, for large chimneys, being cast in segments bolted inside. Eight bolts of two-inch iron up to two and a half inches pass through base ring, foundation, and a washer ring two inches thick. On some large chimneys keys instead of nuts are used under the foundation ring.

A ladder having bars of two by half inch iron, and rungs of five-eighths inch iron through half inch gas pipe, is set six inches from shell and carried over top mouldings by a free curve. The ladder is secured to shell at intervals by ties of four by quarter, inch iron. The brick hole is six feet diameter and the entrance to the foundation chamber is of course between the holding-down bolts. In larger chimneys the size of bolts is increased, but only eight are used.

* * * * These chimneys are constructed on a large factor of safety taking the wind pressure at fifty pounds per square foot, which gives a fair factor itself.

Seven pounds per foot is a high wind, twenty pounds an extraordinarily great storm, and thirty-two pounds a hurricane.

* * * * Nothing can be more beautiful and imposing than one of these chimneys set on grounds of fair prominence where it can be seen from the bottom up. The base curve then has a telling effect. But these base curves require an enormous amount of riveting and consequently cost much money. When the chimney sets among buildings which hide its base the curve may find a cheap and not bad looking substitute in the plain tapering ring construction shown in Fig. 2. As mentioned in my last letter these chimneys may be built, from the bottom up, using an inside scaffold only, or they may be built top end first, the work being lifted and bottom rings added as the work progresses, all the work thus being done on the ground. The character of the lining brick for these chimneys is the same as for ordinary brick ones, and will vary with circumstances. For ordinary work a few feet of the bottom having a renewable lining of fire brick will be all sufficient, while for some blast-furnace purposes, where a flame sometimes shoots twenty feet out of the top of the chimney, the fire-brick lining is best carried clear to the top

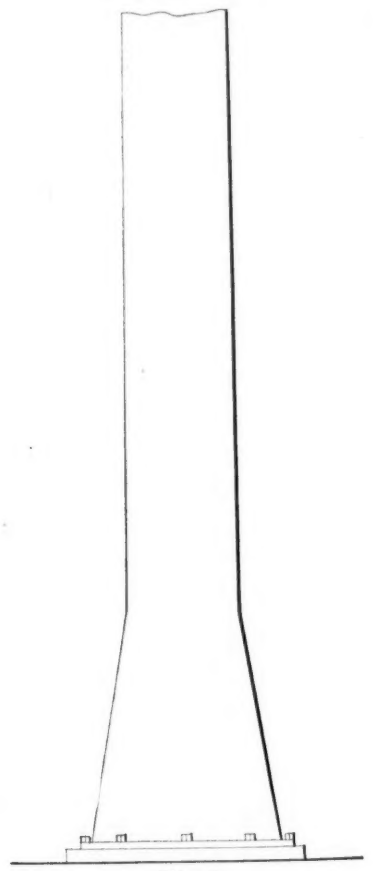


Fig. 2

* * * * A few words about lightning. The thunderbolt desires a good path to the earth, and looks around for the best path whose end is nearest. It grabs the first thing presented, and if that thing happens to be a good conductor of electricity the charge passes harmlessly to the earth. All high chimneys are lightning rods and protect the low property around them by permitting the currents of electricity to flow freely downward to earth.

A wooden chimney being a poor conductor of electricity would offer considerable resistance to the passage of a strong current, and this resistance, like frictional resistance to motion, would undoubtedly permit things to get warm at least. A lightning rod on the wooden chimney would be a means for increasing the conducting power of the chimney by adding a string of metal to it and connecting this metal with the earth.

A brick chimney when wet is a fair electrical conductor and hardly needs a lightning rod. An iron chimney having foundation bolts reaching into the earth is capable of giving silent passage to the most terrifying thunderbolt, and everything around such a chimney, within a radius equal to say the height of the chimney, is effectually guarded.

* * * * Very respectfully,

CHORDAL.

The time for receiving exhibits for the Berlin Hygienic and Life-Saving Exhibition has been extended till June. There is a good deal of interest in the exhibition, in Germany.

How to Preserve Health.

The Citizens' Sanitary Society of Brooklyn, which was organized to enlighten the public regarding the needs of improving the sanitary condition of schools, private dwellings, &c., has issued a "sanitary tract," from which we make the following extracts and commend them to the careful attention of our readers:

Here are a few suggestions for the *prevention* of sickness. They include, first, attention to your home surroundings, and second, to your personal habits.

In regard to the first, one of the earliest physicians, Hippocrates, said that the essentials of health were pure air, pure water and a pure soil. Your home should, above all things, be free from damp. It should not be built upon made land or where it can be flooded by rains or by a rise of tide. Dampness is a certain source of consumption, rheumatism, croup, diphtheria, and other diseases. The nearer your living-rooms are to the ground, the more danger there is of damp. It is better to occupy an attic where you can get the sun and the air than a basement.

* * * * *

Cellar air is unwholesome; and this is another reason why basement rooms are bad. It is very unwise to store vegetables in cellars, or anything that will cause impurity of the air.

Pure air is the most vital thing of all. One may live without proper food and drink, and on a damp soil with impunity, but foul air slays like a sword.

Every person needs pure air to breathe. Each time we empty our lungs a certain amount of impure air is thrown off. Thousands die yearly for lack of pure air. It is free to all; it costs nothing. Open the window and it flows in abundance to the beggar as to the millionare, bringing health and life to all—if only people would not shut and bar it out in their blind, stupid ignorance.

* * * * *

What is it that makes most people sick? Eating too much and too fast; drinking too much; want of fresh air; want of sunlight; want of exercise; want of cleanliness. Few persons die of starvation—many do of gluttony. But you will say, "If I get sick I can't help it—it's only bad luck that brings fever and rheumatism." Not so, my friend. There's no luck in cutting your fingers if you fool with edge tools. More than half the sickness in the world is preventable, as any doctor will tell you.

* * * * *

Make your children wash their hands and faces before going to school. When they are recovering from sickness, do not let them go back to school or play with other children until they are entirely well.

Bathe as often as you can. Remember "cleanliness is next to godliness," and a foul body means a foul mind. Keeping the pores of the skin open is a prime element of health.

Let your wife and children have as much out-door exercise as they can get. It will be a change, and won't do the least harm

Don't sit in damp clothes if you come home wet. If you feel chilled and cold, soak your feet in a pail of hot water; then go to bed and pile on the clothes till you sweat, and you will escape catching cold. In such cases, hot tea, or coffee, or soup is better than whiskey to warm you. In cold countries tea is preferred to any drink. Liquor should never be taken by a sick person, unless by a doctor's orders.

Clothes should fit loosely; should be light, warm and porous; should be adapted to the season as to color; should be frequently changed, and should be scrupulously clean.

* * * * *

In cooking, use the frying pan as little as possible; greasy food is very unwholesome. Avoid pies, too much pork and liquors.

Eat slowly, chewing the food well, and drink very little liquid of any kind while eating. Tea is not food, and too much of it is drunk by many persons, especially women and children.

Don't shut every cranny and crack to keep out the air from the rooms, but let the windows stay open for a time.

Don't forbid the blessed sun from entering your windows. Don't stay in a house that has a bad smell in it.

Don't live in dark, gloomy, close rooms if you can get sunny, cheery ones.

Remove all garbage and refuse as soon as possible.

Have the walls and ceiling whitewashed or kalsomined once or twice every year.

Don't souse water over the floors and stairs even for the sake of cleantiness, as the wood work becomes saturated with moisture, and continual damp breeds disease.

In looking for apartments, always strive to secure a well-ventilated bed room. Air the room and bed clothing every morning. Keep as few clothes, not in use, as possible in the bed room, and do not sleep in any garment which is worn by day. Have no carpet on the floor, but a strip alongside the bed. Wipe off the entire floor once a week with a cloth dampened in water containing a little carbolic acid.

New Key-Seat Cutting Machine.

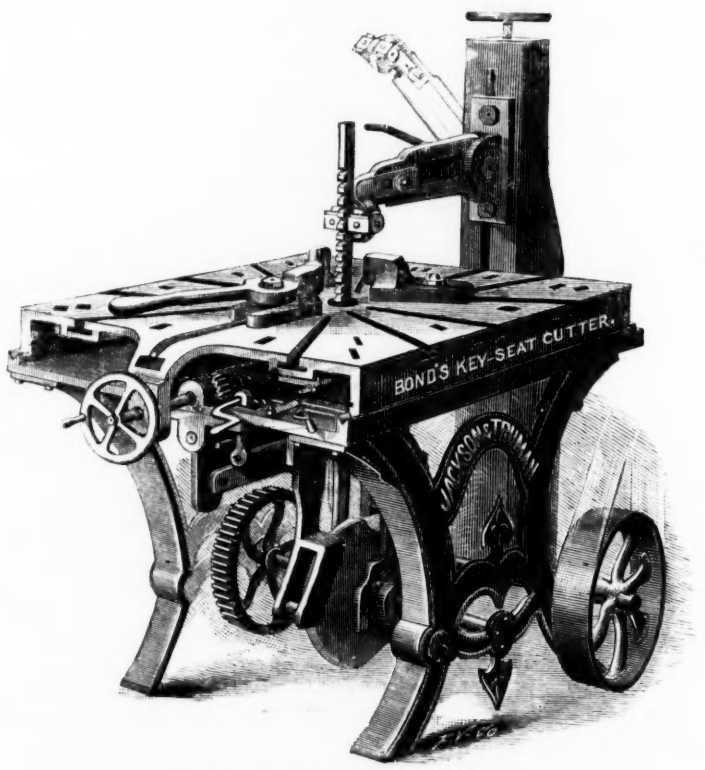
We present with this an illustration of a Key-Seat Cutting Machine, the design of Geo. W. Bonds, of Jackson and Truman's Agricultural Machine Works, San Francisco, Cal. This machine is designed for cutting key-seats of any size up to 1″ wide and 12″ long; also for cutting slots from the outside of pieces.

The work to be operated upon is fastened on the table, which may be fed by hand or by the automatic feed motion. This table is provided with suitable T slots and holes for bolting down the work; also with a three jawed chuck for convenience in doing some classes of work.

The cutter is held in a cross head which receives its motion through a crank. It is held from springing by steel rollers, one at the top and one at the bottom, against which it bears. The arrangement of the cross head is such that it can be set to cut any taper desired. An automatic stop motion in connection with the feed, can be set to cut any depth of key-way, thereby providing for cutting any number of uniform depth.

The table has a relief motion that moves the work away from the cutter on the return stroke, thus preserving the cutting edges. An arm holds the top of the cutter above the work. This arm is shown in dotted lines as swung out of the way for changing work.

In cutting a large number of key-ways in similar pieces, the general arrangement of this machine is such that they may be rapidly operated upon and uniformity of work secured.



New Key-Seat Cutting Machine.

Report of a Trial of Upright Boilers and Worthington Compound Pumping Engine at the Roxbury Pumping Station; Boston, Mass., July, 1879.

By J. S. Coon, Cambridgeport, Mass.

A paper read before the American Society of Mechanical Engineers.

Description of Plant.

The steam-generating apparatus employed during this trial consisted of two upright cylindrical tubular boilers, with internal furnaces, the boilers being located in brick setting. The product of combustion, after passing out at the top of either boiler, was conducted downward external to the shell of the boiler, and in contact with the same, through flues in the brick setting. By referring to the sketch of the boilers, it will be seen that considerable surface was available for superheating.

The principal dimensions of the boilers are as follows:

Diameter of circular shell	84 inches.
Height, over all, about	14 feet.
Diameter of circular grate	69 inches.
Distance from grate to lower tube sheet	2 ft. 5½ in.
Number of wrought iron tubes in each boiler	220.
Length of each tube	10 feet.
Internal diameter of each tube	2¼ inches.
External diameter of each tube	2½ inches.
Water space about fire-box	7 inches.
Grate surface in each boiler	25.96 sq. feet.
" " " both boilers	51.92 " "

Surface exposed to furnace gases in each boiler:

In fire-box	64.3 sq. feet.
Internal surface in tubes	1295 6 " "
Fire surface at top of boiler	33.8 " "
Fire surface external to shell of boiler	112 " "
Total fire surface in one boiler	1506 " "
Total fire surface in both boilers	3012 " "
Ratio of fire surface to grate surface	58 to 1.
Ratio of grate surface to internal cross section of tubes	4.27 to 1.

The Pumping Engine.

The pumping engine, whose duty was incidentally obtained at this trial, was a Worthington compound duplex, of the ordinary type, having horizontal direct-acting steam cylinders and pumps, there being two plungers, each driven by one high-pressure and one low-pressure cylinder.

The principal dimensions of the engines are as follows:

Diameter of high-pressure pistons, each	21 inches.
Diameter of low-pressure pistons, each	36 "
Diameter of high-pressure piston rods	3 "
Diameter of low-pressure piston rods	2¼ "
(There were two piston rods to each low-pressure piston.)	
Diameter of pump plungers, each	17.5 inches
" " " rods	3 "
Stroke of engine No. 1	3.165 feet.
" " " No. 2	3.17 "
Mean stroke of both engines	3.1675 "

Throughout the trial both engines made their full length of stroke.

Method of Conducting the Trial.

The method adopted in conducting the trial is due to Mr. Richard H. Buel, of New York, and was the same as that used by Mr. Buel when testing the Lawrence and Pawtucket pumping engines.*

Before commencing the trial the steam pressure was brought, in the boilers, to the minimum point that would readily enable the engine to do its work. The fires were then hauled, and the furnaces and ash pits cleaned. The fires were then re-kindled with wood, the steam pressure and water level being noted when the fires were lighted. Coal was added at once, and when the fires were in sufficiently good condition the engine was started and continued running until, after the last firing, the steam pressure had fallen to the point at which it stood when the fires were started, the water level being also the same. The engine was then stopped, the fires hauled, and the unconsumed coal picked out. This latter was deducted from the total coal supplied to the boilers during the trial, the remainder being charged to the experiment. The wood used in starting fires was also charged to the experiment, it being estimated as equivalent to 4-10 of its weight in coal.

The coal used during the trial was selected "Old Company's" Lehigh of the very best quality.

During the trial the feed water was supplied to the boilers directly from the street main, and its mean temperature was 74.56° F. Ordinarily the feed water enters the boilers at 130° F., but as suitable connections could not be made for gauging the water after it was heated, it was supplied at the temperature of the street main. During the ordinary daily work the feed water is heated by the exhaust steam from the direct-acting boiler feed-pumps.

It was inconvenient to weigh each draught of feed water. It was gauged in a barrel fitted with fixed hook gauges, and by these uniformly filled and discharged each time, each draught weighing 374 pounds, as previously ascertained. From the measuring barrel the water was run into another, to which the pump connection was attached.

A mercurial column indicated the pressure per square inch in the force main, i. e., the forward pressure against which the engine pumped. The mean of the recorded observations made on this gauge indicated a pressure of 78.703 pounds per square inch.

The water supply for the main pumps was drawn from a street main under pressure, which assisted the engine in pumping. A mercurial column was used to indicate this back pressure. The mean of the observations taken from it indicated a pressure of 27.11 pounds per square inch.

The zero of the force-main gauge was 4.64 feet above the zero of the back pressure gauge,—being equivalent to about 2.008 pounds per square inch additional pressure. The head against which the engine pumped was, therefore, (78.703+2.008)—27.11=53.6 pounds.

The boiler pressure gauge had been previously tested.

Tubes partially filled with oil were inserted into the flues to determine the temperature of the products of combustion as they left the boilers. Thermometers immersed in the oil indicated the temperatures.

A thermometer was inserted into the main steam pipe, about 10 feet from either boiler, to indicate the temperature of the steam.

A thermometer was inserted into the feed pipe, between the feed pump and the boilers, for indicating the temperature of the feed water. A thermometer was also immersed occasionally in the measuring barrel, during the early part of the trial, to obtain the temperature of the feed water. But as its indications agreed exactly with those of the thermometer in the feed pipe its use was subsequently discontinued.

A mercurial column indicated the amount of vacuum obtained in the condenser. This gauge indicated 0.4 inches too much.

Throughout the trial observations were made every thirty minutes on the engine counter (which indicated every four strokes of the engine); the force-main pressure gauge; the back pressure gauge; the vacuum gauge; the steam pressure in boilers; the temperature of the steam in the steam pipe; the temperature of the boiler flues; the temperature of the feed water, and the temperature of the engine room.

Indicator diagrams were frequently taken from all four steam cylinders throughout the trial. The cards show a very uniform pressure in the high-pressure cylinders, not only throughout each single stroke, but also throughout the entire trial.

One man was engaged whose sole duty was to measure the feed water.

Results of the Trial.

Fires were hauled and ash pits cleaned at 4:50 A. M. Fires were lighted at 5:07 A. M., with boiler steam gauge at 29.5 pounds.

One hundred and fifty pounds of wood were used in each boiler to start fires.

The engine started at 5:50 A. M., with boiler steam gauge indicating 44.5 pounds.

Engine run continuously till 9:21 P. M., when it was stopped—the boiler pressure having fallen to 29.5 pounds, and the water standing in the glass gauge cocks at the same point as when the fires were lighted, viz., 5:07 A. M.

The fires were hauled immediately after the engine was stopped.

Duration of trial, from the time the fires were lighted, at 5:07 A. M., till they were hauled, at 9:21 P. M., was sixteen hours and fourteen minutes.

Time during which engine was run, viz., from 5:50 A. M. till 9:21 P. M., fifteen hours and thirty-one minutes.

The following table gives the mean and total quantities as recorded in the log:

Mean pressure in force main, pounds per square inch	78.703
Mean pressure in suction main, pounds per square inch	27.11
Difference, pounds per square inch.	51.593
Correction for difference in zero points, pounds	2.008
Mean corrected head against pumps, pounds per square inch	53.6
Mean corrected vacuum, pounds per square inch	12.55
Mean steam pressure at boiler's gauge, pounds per square inch	38.985
Mean temperature of the feed water, F	74.561°
Mean temperature of the steam in main steam pipe, F	352.5°
Mean temperature of the flue, boiler No. 1, F	317.3°
Mean temperature of the flue, boiler No. 2, F	316.9°
Mean temperature of the engine room, F	84.°
Total indications of engine counter.	11312
Total number of pump strokes	45248
" pounds of water evaporated.	29876.5
" " wood used to start fires	300
Total pounds of wood used in coal equivalent at 40 per cent	120
Total pounds of coal put into furnaces	3711
Total fuel, in coal equivalent, pounds	3831
At the close of the trial there was drawn from the grates, pounds.	511
Ditto from ash pits, pounds	256
Total ashes and unburned coal from both grates and pits, pounds	767
Total unburned coal picked out from the above, pounds	519
Total coal consumed, 3831—519, pounds	3312
Total ashes, 769—519, pounds	248
Percentage of ash in coal	7.48
Total combustible consumed, 3831—767, pounds	3064

Actual Duty of the Pumping Engine During the Trial.

Total head against pump, net, per square inch, pounds	53.6
Mean area of plungers, square inches	236.994
Total indications of the counter	11312
Feet traveled by the plungers at each indication of the counter	12.67
Total coal consumed, pounds	3312

Hence, duty was (foot pounds per 100 pounds of coal),

$$\frac{236.994 \times 53.6 \times 12.67 \times 11312. \times 100}{3312.} = 54{,}970\ 264$$

* [A summary of these tests was published in the American Machinist of August 16, 1879.]

TRUE DUTY WITH WHICH THE ENGINE SHOULD BE CREDITED.

As previously stated, the feed water is ordinarily supplied to the boilers at a temperature of 130° F., instead of the temperature named during the trial, viz., 74.561°. Hence, the actual duty, as previously given, is less than the duty which should fairly be credited to the engine.

The thermal units imparted to one pound of water at 74.56° in converting it to steam at 53.69 pounds absolute pressure (38.985 pounds gauge), and superheating it to a temperature of 352.5°=1150.78 thermal units.

The thermal units which would be imparted to 1 pound of water at 130° to steam at same pressure, and superheating as given above = 1095.17 thermal units.

Hence, in consequence of using the cooler feed water, the consumption of coal was increased in the ratio of 1150.78 to 1095.17, or 5.078 per cent., bringing the duty of the engine up to 57,761,517 foot pounds.

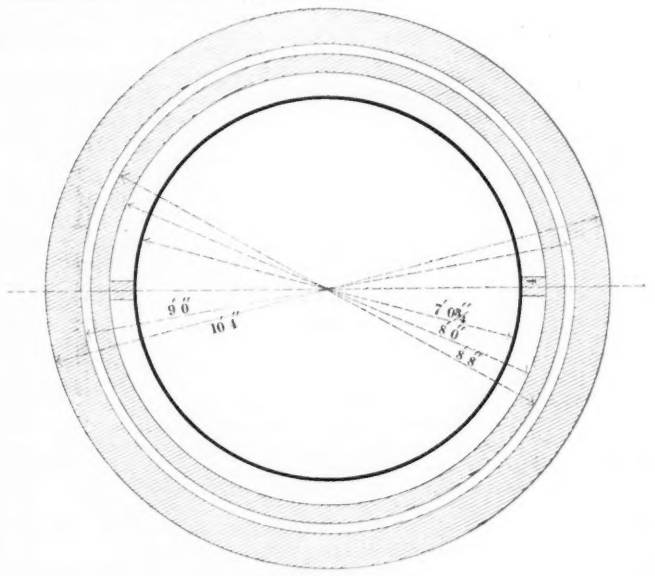


Fig. 2.
Section at A. B.
SECTIONAL PLAN OF BOILER

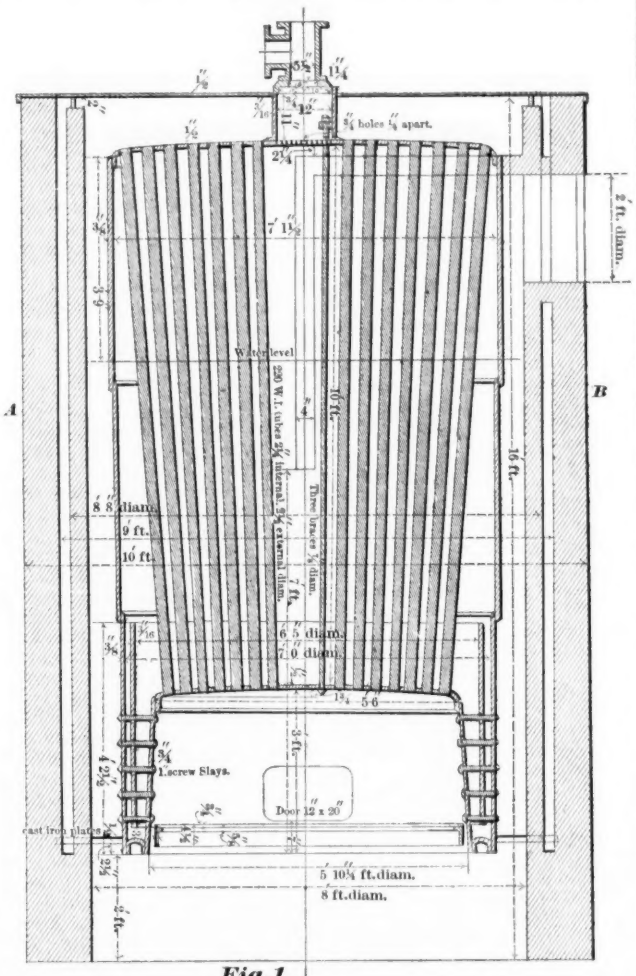


Fig. 1.
SECTIONAL VIEW OF BOILER.

EFFICIENCY OF THE PUMP.

From a mean of several sets of indicator cards taken at wide intervals during the trial, the percentage of the pressure on the pump plungers was 90.775 per cent. of the pressure on the steam pistons, the water pressure on the plungers being taken at the same time the cards were taken from the steam cylinders.

SUPERHEATING.

Mean observed steam pressure at boilers, by gauge	38.985 pounds.
Mean barometric pressure (29.938 inches mercury)	14.705 "
Mean absolute pressure of evaporation, per square inch	53.69 "
Temperature of evaporation corresponding to this pressure	285.7° F.
Mean observed temperature of steam in main steam pipe	352.5° F.
Degrees which steam was superheated	66.8° F.
Thermal units imparted to each pound of steam in superheating (66.8×365)	24.38
Thermal units required to evaporate 1 pound of water from 74.56° F. to saturated steam at 53.59 pounds, =1126.4	
Increase due to superheating.	2.16 per cent.

HOURLY QUANTITIES.

Pounds of coal	213.7
" combustible	197.7
" coal per square foot of grate	4.115
Pounds of combustible per square foot of grate	3.807
Pounds of coal per square foot of fire surface	0.0794
Pounds of combustible per square foot of fire surface	0.0656
Pounds of feed water per square foot of fire surface	0.64

EVAPORATION.

Pounds of water per pound of coal, at observed temperature and pressure	9.027
Pounds of water that would have been evaporated per pound of coal at observed pressure, had feed water been at 130° F.	9.463
Pounds of water evaporated per pound of combustible at observed temperature and pressure	9.7508
Pounds of water evaporated per pound of combustible at observed pressure had feed water been supplied at 130° F.	10.22
Pounds of water evaporated per pound of coal, from and at 212° F., neglecting superheating	10.515
(Factor of evaporation being 1.1648.)	
Pounds of water evaporated per pound of coal, from and at 212° F., taking into account the superheating	10.742

The quantity 10.515 represents the actual evaporation from and at 212° F. The quantity 10.742 represents what the evaporation would have been if the steam had been sent to the engine dry saturated, and supposing the products of combustion to have been cooled to an equally low degree.

Pounds of water evaporated per pound of combustible, from and at 212° F., neglecting superheating.	11.358
Pounds of water evaporated per pound of combustible, from and at 212° F., taking account of the superheating	11.603
Pounds of water evaporated per hour, per square foot of heating (fire) surface, neglecting superheating	0.745
Pounds of water evaporated per hour, per square foot of heating (fire) surface, taking account of superheating	0.759

The factor of evaporation given above, viz., 1.1648, is based on the observed temperature of feed water, viz., 74.561° F., and on the temperature of evaporation corresponding to the mean observed boiler pressure, viz., 38-.985 pounds gauge. Taking into account the superheating the factor of evaporation becomes 1.1864.

HORSE POWER DEVELOPED.

Area of pump plungers, mean, square inches	236.99
Head against pump, pounds per square inch	53.6
Mean indications of counter per minute	12.15
Feet traveled by plungers per each indication of counter	12.67
Hence, net horse power = $\frac{236.99 \times 53.6 \times 12.15 \times 12.67}{33000}$ =	59.26
The efficiency of the engine being, as previously given, 0.9077, the indicated horse power = $\frac{59.26}{.9077}$ =	65.28

PERCENTAGE OF BOILER PRESSURE REALIZED IN HIGH-PRESSURE CYLINDERS.

The mean pressure above the atmosphere from all the high-pressure cards was, pounds per square inch.	15.5
Mean barometric pressure	14.7
Mean absolute pressure realized in high-pressure cylinders	30.2
Mean absolute pressure of steam in boilers	53.60
Percentage of boiler pressure realized in high-pressure cylinders	56.2

THE RELATIVE AMOUNT OF WORK DONE BY THE HIGH-PRESSURE AND LOW-PRESSURE CYLINDERS, RESPECTIVELY.

The following quantities may represent the amount of work done at each end of each steam cylinder for each engine, as given by the indicator cards:

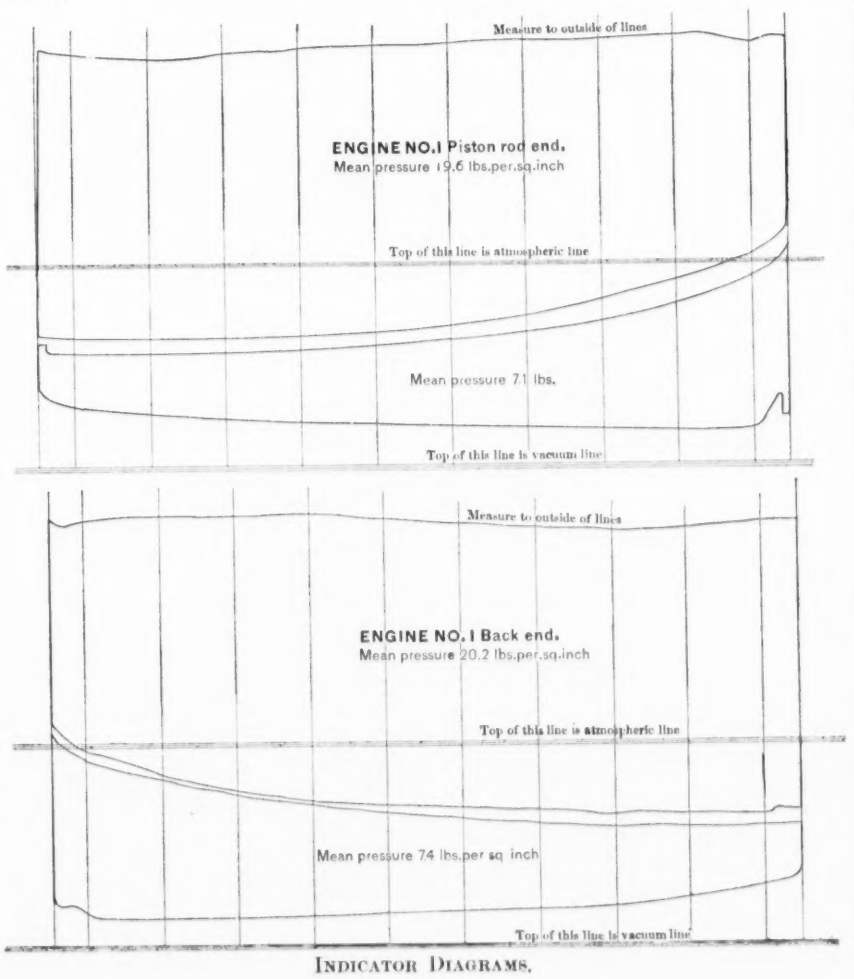
High-pressure cylinder, back end, right-hand engine	6916.8
High-pressure cylinder piston-rod end, right-hand engine	6609.4
High-pressure cylinder, total for both ends, right-hand engine	13526.2
Low-pressure cylinder, back end, right-hand engine	7573.0
Low-pressure cylinder, piston-rod end, right-hand engine	6968.5
Low-pressure cylinder, total for both ends, right-hand engine	14541.5
High-pressure cylinder, back end, left-hand engine	6961.8
High-pressure cylinder, piston-rod end, left-hand engine	6534.7
High-pressure cylinder, total for both ends, left-hand engine	13496.5
Low-pressure cylinder, back end, left-hand engine	7400.0
Low-pressure cylinder, piston-rod end, left-hand engine	7271.5
Low-pressure cylinder, total for both ends, left-hand engine	14671.5
Total high-pressure work done by both engines	27022.7
Total low-pressure work done by both engines	29213
Percentage of work done by high-pressure cylinders	48.05
Percentage of work done by low-pressure cylinders	51.95

POUNDS OF COAL AND WATER USED PER HORSE POWER PER HOUR.

Pounds of coal per hour per net horse power, at observed pressure and temperature of feed water	3.606
Pounds of coal per hour per net horse power, at observed pressure, if feed water had been supplied at 130° F.	3.432
Pounds of coal per hour per indicated horse power, at observed pressure and temperature of feed water.	3.27
Pounds of coal per hour per indicated horse power, at observed pressure, if feed water had been supplied at 130 F.	3.11
Pounds of feed water per hour per net horse power	32.53
Pounds of feed water per hour per indicated horse power	29 52

STEAM ACCOUNTED FOR BY THE INDICATOR CARDS.

Assuming that the independent feed pump took 1 per cent. of the feed water supplied


Measure to outside of lines
ENGINE NO. 1 Piston rod end.
Mean pressure 19.6 lbs.per.sq.inch
Top of this line is atmospheric line
Mean pressure 7.1 lbs.
Top of this line is vacuum line
Measure to outside of lines
ENGINE NO. 1 Back end.
Mean pressure 20.2 lbs.per.sq.inch
Top of this line is atmospheric line
Mean pressure 74 lbs.per sq. inch
Top of this line is vacuum line

INDICATOR DIAGRAMS.

to the boilers, and assuming a clearance of 2 per cent. at the low-pressure cylinders, the indicator cards account for 87 per cent. of the feed water supplied to the boilers.

It may be well to add that the object of this trial was to obtain additional data for deciding on the type of boiler to be used with the improved sewerage pumping engines at Boston, and was authorized by Mr. Joseph P. Davis, then city engineer, Boston. The trial was conducted under the direction of Mr. E. D. Leavitt, Jr. The data taken from the Worthington engine was merely incidental. In order to avoid any imputation of unfairness, all observations were made jointly by myself and by Mr. Dexter Brackett and his assistants from the City Hall, Boston.

The Demand for a New U. S. Board to Test Iron and Other Structural Materials.

At the Philadelphia meeting of the American Society of Mechanical Engineers, one session was devoted to a report of a committee appointed to consider the propriety of the re-organization of the movement looking towards the formation of a new board to test iron, steel, metals, and other materials. Following are the proceedings, as stenographically reported for the AMERICAN MACHINIST.

Prof. EGLESTON, chairman of the committee gave the history of the board to test iron and steel established, and related how the commission was finally legislated out of existence just at a time when it was in a position to accomplish important results. In mentioning some of the work accomplished by the commission, he said: An entirely new system of applying testing machines has been used. The testing machine, designed and built by A. H. Emery for the Government, has been found to be of extreme accuracy. It has been found, as the result of the mechanical work done by this commission, that there is no relation between tests of sections of diminished area with those of large area. Heretofore we supposed that there was a direct relation between the two. Now, we must not only test materials full size, but the constructions themselves. The commission had got to the point where it was about to commence the tests, when the whole thing fell through, and it is desirable now that the same commission be reappointed to carry on the work where the old commission left off. I presume every engineer, or any one who has ever used materials, knows how unsafe different materials sometimes are, because we do not always know beforehand exactly what materials are going to do. The old board confined its work mainly to what work could be done with the testing machine. If there was any fault to be found with the board, it was that they delayed nearly all the work until the testing machine was built. They waited for the testing machine, supposing that it was so large a factor in the work to be done that it was necessary to have the testing machine before they commenced. I do not say this in criticism, because you must remember that the circumstances are very different now from what they were when this commission was established. We commence where they left off. There was a work done by the commission which has been entirely lost sight off. Some manufacturers undertook to make compounds of iron and carbon, or other materials, never before made. They tested them to find out what their hardness was, and of exactly what use they were capable. It was found, in the course of these experiments, that many of these compounds were capable of no use, and therefore that was a question that was eliminated at once. The reports of this work have never been made, but the material is in existence. As far as these materials are concerned, we are constantly coming into dark points in metallurgy that need clearing up. And which never can be cleared up by private parties but only by a government commission.

I have collected here, mainly from the reports of the MS. census, a few facts, which I propose to run over very rapidly, and afterwards have them put in print. The amount of capital invested in iron and steel during the year 1881 amounted to $231,000,000, the value of the materials which were manufactured was $191,000,000, and the value of the products amounted to $297,000,000. The total production for that year was 7,500,000 tons; of rolled iron, 2,000,000 tons; of Bessemer steel, nearly 1,000,000, and so on. In bridges alone 80,000 tons of iron were used, which is equivalent to fifty miles of bridges placed end to end consecutively. With regard to these structural materials, what do we know? We have a whole series of tables of factors of safety—formulæ which were constructed some years ago by foreign engineers mainly upon materials not used here, as iron of foreign manufacture. Within the last fifteen or twenty years we have not only produced materials entirely different, from those from which these formulæ was deduced but we are manufacturing materials for structural purposes almost entirely different processes. If any one had said fifteen years ago that it would be possible to produce a cast iron which would not be attacked in any way by aqua regia, or that we should be able to produce it in large quantities to be used for metallurgical purposes, in place of platinum, he would have been considered hasty in making such a statement. It has been found, since the commencement of the labors of the old commission, that five per cent. of certain materials, added to certain kinds of cast iron, makes it almost entirely unattackable in ordinary acids; that boiling sulphuric acid does not attack, although some of the weak acids do. It has been found that ferro silicon is not attackable by aqua regia, and could not be brought into solution except by a solution of bromine, strongly concentrated. We have found a good many Bessemer steel companies making ferro-phosphorus, which is a material never known which can only be cleared up by extended investigation. I might mention that by investigation it might be found useful for other purposes besides in the manufacture of Bessemer steel. There are dark points in our knowledge of metallurgy and in our use of material until the toric tepemie process was invented. Secondly, we must look to the structure of the material. Iron, under certain condition of blows, would become crystaline, and consequently would not be safe material. Much of the iron we use is subject to constant vibrations and blows and will become weak, if it is not so already. We ought to be able to distihguish snch irons. We ought to know the best forms so as to enable us to use less of such material. In order to accomplish this, a large amount of time and money and skill and experience would have to be brought into requisition, and could only be done by such a commission as is proposed, appointed by the United States Government, not only to take the modern materials and test them according to the rules that we understand now, but also to develop entirely new methods of research—chemical, physical and mechanical—in order to find out exactly for what purposes certain materials are used.

A few monts ago I was called upon by the manufacturers of cartridge material to investigate what was the cause of the rupture in certain conditions of pieces of metal that were apparently exactly alike, that were made exactly the same way apparently and of the same materials—to ascertain why it was that a certain piece of material, made of copper and zinc would break under certain circumstances while the same material under similar conditions would not. In the course of this investigation I had occasion to test very large amounts of brass or copper and zinc, and of the alloys of copper and zinc in different proportions, and came across the astonishing fact, that in firing cartridges made for that purpose out of very fine material it was possible under certain conditions to have a cartridge that could be fired and reloaded 150 times, and that it was also possible that some gave out the very first time they were fired. It was also found that a cartridge that would stand all the tests of which cartridge metal was supposed to be capable would after a certain time, say three, four, five or six months not bear bending with an ordinary pair of pincers. Here was a case of fatigue of metal. This same condition occurs in all metal that is "punched." struck up or spun. The production of copper in the United States in 1881 was about fifty millions of pounds and about two-thirds of it was manufactured into brass and about one-third of this metal was used in materials that were punched.

The speaker went on to state that the fatigue in brass under certain conditions was so great on account of the pressure that this cold flow would be commenced. I have seen, he said this operate so far that the zinc actually separated from the copper by pressure. Neither the copper nor the zinc, but the brass was fatigued. I saw this done to such an extent that I became convinced that under proper conditions it would be possible to separate metals in alloys by producing cold flow in them by pressure. How far we can obviate such difficulties as these is not known and cannot be known except the conditions of its manufacture are observed. It must be investigated by the commission as it will require an amount of time and expense that no single manufacturer could bear. The objection has been made to me against the appointment of this board, that every manufacturer should make these investigations for himself. So he should! We all understand that anybody in the manufacturing business should make investigations that will give him knowledge, and will increase his profits and reputation. But such investigations being made by a private individual are kept secret and thus do not add to the sum of human knowledge, and if we suppose a hundred manufacturers making investigations, then one hundred times the amount of money that is necessary will be spent and nothing is added to the general knowledge of the subject. The Government is the largest consumer of any one kind of metal, and next to the Government come the railways, but the Government is most interested so far as the use of these metals is concerned. I made a rapid calculation some time ago that if three per cent. could be saved by the investigation of such a commission in the amount of iron produced and used in structural materials, there would be a saving to the Government of about $250,000 annually. Of course that is an amount which would far exceed the expenses of any such commission as this, and if the material used in the construction of bridges and railroads, there would be saved an amount of money which would be almost incalculable so far as our present knowledge goes, in the fact that not only property but also a very large number of lives would be saved. By studying the best forms for their interests is quite possible that other shapes may be found which would materially diminish the weight of bridges and other structures. Of course there are a great many other things besides form alone, that are to be considered. I think it is settled that it is necessary for us to go over what are called "the factors of safety," and to go over the formulæ which are now used by engineers. In order to do this it is necessary that the commission should have machines and materials and almost unlimited means. I think it is settled too that researches that are made of sections of diminished area are not to be depended on. If you are going to test the strength of a bridge, or parts, you must test by the full size. Other materials besides iron used in construction should be tested in this way and the quantity and quality of a material with a fair test might bring a result entirely different from the factors of safety that are used now. I think we may say the factors of safety we are using now are the exponents of our ignorance, that we really are overloading our structures, and thus instead of making them a source of strength, making them a source of weakness. We must look in the future to see whether we cannot make less material produce the same result. Nobody but a commission of this kind can make experiments of this character. We must make less material do more work. We must in fact try to do what the Creator has done in rye straw. A rye straw will bear a weight of seven ounces, but if the material of which it is composed were put in a solid form it would bear no weight at all. It is necessary for the commission not only to see that the quality of the materials is improved, but to see that the material is used in the very best way; and new forms of material should be set up in order to produce the best effect with the least amount of material.

Some years ago at the Montreal meeting of the Mining Engineers, I read a paper on the law of fatigue and refreshment of metal. This law has assumed proportions which appear to be much greater than I had thought possible at the time. It has turned up since I have been investigating the law of fatigue, and other engineers have remarked the same thing that there are very different kinds of fatigue of which we know but very little. I mentioned in the paper that I read at Montreal the fact that some metals become fatigued by apparent rest, as in the case of cartridge metal in one case where fatigue was developed by the fact that no work was done by the metal. There was a case of some rings that had been walled up in the steeple of a church for nearly two hundred years and when they were uncovered it was found they were in the form of an impalpable powder. It was supposed at first that the rings had oxidized and that the result was the oxide of tin, but it was found that upon the application of a little heat they were restored to a metallic form. The restoration from fatigue which occurs by rest has been better illustrated by a fact which is known to cannon manufacturers, an example of which was shown, by an example cited, to me by Mr. Metcalf, who made a great many cannons for the Government. It is the law of the Government that any cannon which is condemned shall be immediately broken up. One of the cannons condemned by the Government officials got covered up in sand and laid there for 15 years, and when it was dug up and tested it was found that not only was this cannon not fatigued, but that it bore an amount of fatigue that could not have been borne by an ordinary cannon.

Metals are not the only things the commission ought to examine; in fact everything that is used in any way whatever in the construction of machines or buildings should be examined. I had a discussion some time ago with a large firm of boiler makers in this city, who told me that when they began to draw specifications for making boilers there were no investigations satisfactory that they could rely upon for use, and that even in ordinary cases they were obliged to go to the iron manufacturers and demand certain things of them which the iron manufacturers told them were impossible to do; some things that were absolutely necessary to make the boiler with ordinary safety. Of course there was a United States Commission which tested boilers. I think there ought to be a commission concerning this and all other things of the same nature.

C. J. H. WOODBURY: I think we ought all to favor this measure whether we are constructors or whether we are owners of buildings, or bridges, or structures of any kind. There is an amount of failure in general construction which never becomes known, because those concerned in it are very careful not to have the methods and failures known. In most matters of construction we have only a precedent to rely upon, and of course that precedent becomes faulty when the nature of the materials change. It is an axiom throughout the physical sciences and the mechanic arts that it is bad policy to work from the less to the greater, because the errors are augmented, and in the construction of various materials the construction is no multiple of the construction of a part. Even the data we have is largely drawn from foreign materials and from foreign experimenters, and even those experiments have been carried out on a very small scale. The formulæ we have as regards the strength of wooden columns are based upon the consideration of columns of Dantzic oak, a material not known in our markets. The tables were made a good many years ago and the columns tested were very small, some two inches in diameter, and were mere models. The strength of wooden columns is a question the Commission should be brought face to face to.

OBERLIN SMITH suggested that the matter of the re-inauguration of the Commission should be agitated among men of influence, whose names should be secured to a petition to be sent to Congress.

WM. M. BARR: Several years ago I had occasion to make a cotton press in the South, and the talk about these machines for testing the strength of materials brings to my mind now the failure of that press. The top platen on the press was made of cast iron. This was supported by four wrought iron bolts six inches in diameter, and these bolts had on the top of them cast iron nuts. These nuts were made in accordance with the Franklin Institute thread. The speaker went on to describe the press, and said that, notwithstanding every precaution had been taken, in less than two weeks after the press was first run the platen broke at a pressure of about two thousand pounds. He thought the Watertown machine would be valuable to test the strength of large castings and the cause of their failure.

W. BARNET LE VAN: It is necessary that we make our experiments, not on small dimensions, but on materials as they are found in practice. In a good many cases it would be impossible to do this absolutely, and then it is only by coming as near as we can to pratice in forming our judgment on our facts we observe, that we can do our best engineering work.

Built-up Work in Engine Construction.

BY HORACE SEE.

A PAPER READ BEFORE THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

This paper is intended to treat, in as general and brief a way as possible, of some of the advantages resulting from the use of built-up work in engine construction.

It will be desirable for you, before proceeding farther, to understand what is meant by the term "built-up," as applied to the subject under consideration. We mean a structure formed by the union of several simple members, these members or pieces being such as can be most conveniently, quickly and economically made, to give the required strength.

Some object to this form of construction from mistaken ideas of economy, others from a false interpretation of beauty, but the largest class from extreme conservatism.

The advantages can be better understood by considering how a few of the forgings and castings, shown in the accompanying illustrations, entering into the construction of a compound marine propeller engine, are made.

The following extract from a letter in *Engineering*, of August 19th, 1881, strikes the key note of the subject: "The fact will doubtless have its influence for all time coming, when the shafts for gigantic steamers are to be ordered, as it is absolutely impossible to insure that a forging shall be perfectly sound and destitute of flaws if, when it leaves the hammer, it is such an immense and ponderous mass as to weigh fully thirty tons, as did the one fitted into the Servia, being eventually finished, however, at about eighteen tons in weight. All such shafts in future will doubtless be built."

The same argument applies to the solid forked connecting rod, which requires about

50 per cent. of its weight to be taken off after leaving the hammer, with the attendant risk of not discovering the flaw until near the completion of the work. The impossibility of insuring soundness in forgings which require from 40 to 50 per cent. of their weight to be taken off after leaving the hammer, to bring them to the proper finished shape, should certainly cause the abandonment of a practice with so much uncertainty hanging over it, and lead to the adoption of one where the hammer can fashion each piece to near the required shape, where but a small portion of the tough material has to be removed, and where the risks are a great deal less. All of these requirements are met by the built-up system, which has also the additional advantage of furnishing to the forge such shapes as can be more easily made with the fibers of the material running in the proper direction.

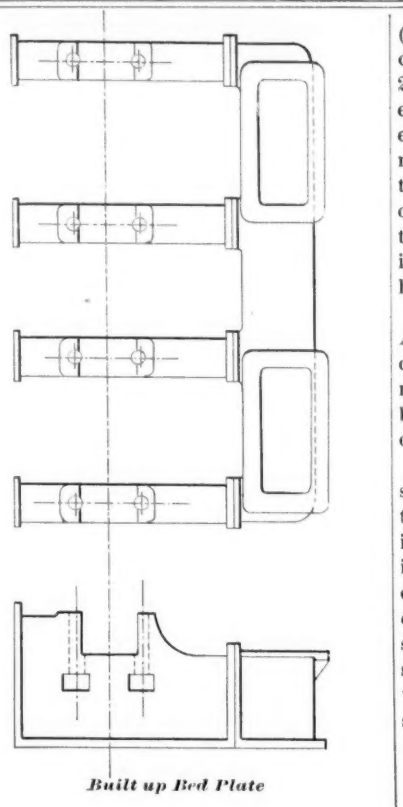
With castings the evils resulting from crowding too much into one piece are of an analogous character. We will take a bed plate to illustrate this. Two patterns, each consisting of one fore and aft and two athwartship members have to be made, and the mould for each built up in loam.

It is quite likely that the moulding of one will have to follow the other on account of a limited amount of room in the foundry, either on the floor or in the ovens. In the machine shop the largest planing machine is called into play and that, quite possible, not able to plane more than one piece at a time. Each piece will also have to be set twice.

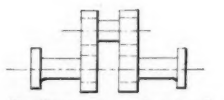
Here the evil is not so much from the weakness of the structure, as from the adoption of a slow and expensive system. This system will doubtless have to give place to the built-up, by making each member of the bed separate, where but one pattern is required for the athwartship and another for the fore and aft pieces. This subdivision also allows you to make the castings in green sand. All of the athwartship pieces can be planed together at one setting, as well as the fore and aft one, on a smaller planer than in the other system.

This subject could be elaborated, but I think enough has been said to call attention to and furnish food for reflection upon a very important part of steam engine construction.

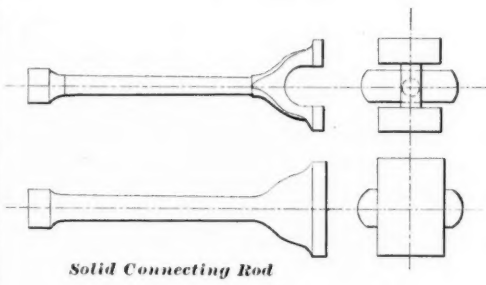
Solid Crank-Shaft.



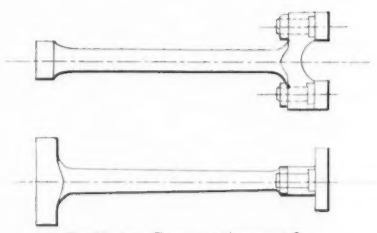
Built up Bed Plate



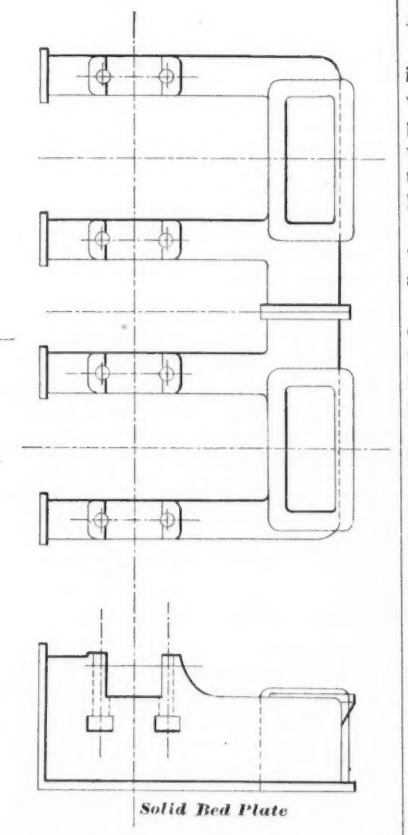
Built-up Crank-Shaft.



Solid Connecting Rod



Built-up Connecting Rod



Solid Bed Plate

LETTERS FROM PRACTICAL MEN.

Lathe Centers and Center Reamers.

Editor American Machinist:

In your issue of April 8th are three communications referring to my articles.

The first is from Mr. Simonds referring to the one on preparing work for lathes; center reamers, etc. In reply I desire to say that the article referred to, was written with the object of raising my feeble voice against the practice which is common in many shops, of sending out work without proper centers, and was called out by an examination of some new machinery sent out to Montana from the East, on some of which the turned work had no centers, some did not have the ends squared up at all (only with a file), and on squared up ends, ugly looking tits and burrs had been left. The work referred to was made by one of the Eastern shops which claim to turn out first-class work. Now what *mechanic* can see such work without having his teeth set on edge? Now in regard to the half center advocated by Mr. S., I will say that I have used a similar device, to wit: a center with a groove of circular section filed like the accompanying engravings, in which Fig. 1 is a side view showing groove *A*. Fig. 2 is a section view through *x*, *y*. I used this center on heavy work and made it especially for its convenience in lubricating the centers without slacking up. I have also used the groove to admit the point of a graver so as to turn off the burr left after the side or squaring up tool. I believe the chief difficulty with this device was that, of the trouble of re-dressing the same when worn. I would like to ask Mr. S. how his center works on ordinary taper work in a set over lathe; it seems to me that it would bore in somewhat if it did not do the same on straight work, but "the proof of the pudding is not always in chewing the bag string," Mr. S. is not willing to admit that I am up to the times in making a center reamer, but I have made and used the kind he describes, but did not like them as well for the following reasons: first, it is more work to make them if filed up to shape; second, it is a tool which has a very little cutting to do, and if properly made and tempered will do an immense quantity of reaming (unless used on hardened steel or something of that kind), before it needs grinding, (a small amount of which can be done on the tool I described, without appreciably altering the form or destroying its cutting properties), and by which time the point will usually be worn off in such manner as to destroy the correct angle required, and the tool should then be re-dressed, or re-turned. As made by Mr. S. it is impossible to re-turn the tool to gauge for the reason that the extreme point has been made and ground below the center line, and a point cannot be obtained, or the angle gauged, until you take off all of the original cone. The following sketches will show that when the face is made and ground below the center line, the only part left which can be gauged is the face, hyperbola, instead of a triangle.

Referring to the engravings, Fig. 3 is a side view and Fig. 4 a top view in which *A B* is the central line, *a b c* the form of original cone, *a' b' c'* shows the attempt to re-dress; *d E* in Fig. 3, is the plane to which face has been ground or dressed down to, and *b d c* Fig. 4, shows the hyperbolic curve which is generated by the plane *d E*, cutting, the cone *a b c*, the dotted line *b d c* Fig. 4, will show that the resulting hyperbola is the same after dressing back to *a b c*. Now this is all well enough theoretically, and might be practically if the center reamer was a tool which had to be fitted to an *unmechanical* taper drill socket, or required any great amount of work to make it. But in what I believe to be the best practice, they are a very inexpensive tool to make and are very long lived if properly used. They need not cost more than a few cents apiece, and when used up could be thrown away almost, cheaper than to grind or re-turn them.

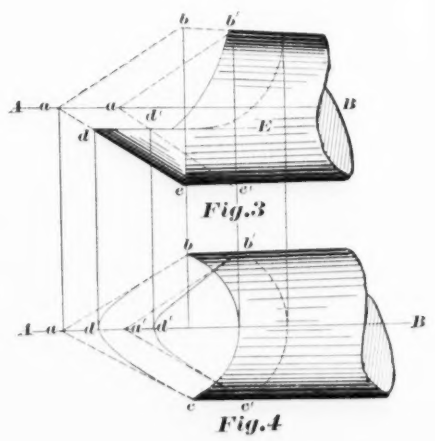


Fig. 3

Fig. 4

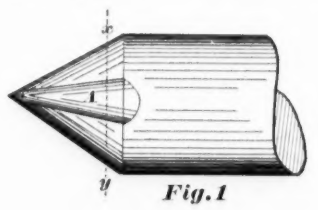


Fig. 1

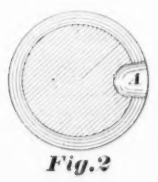


Fig. 2

It may be of interest to some of your readers to know just how I make them. First, I always use a straight round hole for drill chuck, as shown in one of my former articles, (or a universal drill chuck). I cut off pieces of round tool steel of size to fit chuck, about 2½ to 3 inches long, flatten spots long enough to take the set screw when placed either end in the chuck, then turn up and make reamers on each end. A dozen or so of these can be made at one time. Harden all over, draw the temper by holding them in the center with a pair of hot tongs and placing them in a tempering sleeve such as I have heretofore described.

The second communication is from Mr. Alden. I think if there are any who are not convinced by the demonstration I gave in regard to turning tapers, they cannot help being convinced by Mr. Alden's excellent demonstration of the problem.

The third is from "Machinist." I cannot see how his method differs materially from the one I use to cut a chaser, except, that his is not quite as accurate a method of dividing the circle as the one I adopted, neither do I think there would be any great saving of time, especially on a small jeweler's lathe such as I used. I do not now remember the size of the wheel I used, but it was as large as would swing, and of course I took up all the slack or lost motion of feed screw.

Helena, Montana. GEO. B. FOOTE.

Grinding a Screw Tool.

Editor American Machinist:

In your column of questions and answers in issue of Mar. 25, you answer a question with reference to grinding a screw tool the proper angle for cutting a square thread in a way that I think would hardly be intelligible to the one who asked the question. I feel like taking exceptions to your use of the term "bevel square," but letting this pass, I wish to indicate a plan for making a gauge for the angle of the sides of the screw tool.

Take a piece of sheet brass with one straight edge. With a scratch gauge draw two lines representing the outside diameter of the screw to be cut, and by using a square draw a line perpendicular to, and intersecting these lines. Now say the screw is to be two threads to the inch, or ½" pitch; space to the left on the upper horizontal line from the point where the vertical line cuts it, ¼", and from this point draw a line that shall cut the lower horizontal line at the point of intersection with the vertical line. This will represent the angle for the tool. In practice it is better to make the clearance somewhat greater than this, but of course never less.

The reason for spacing back ¼" is that this is one-half the pitch, which is just what the thread has advanced in one-half a revolution, or its diameter.

C. E. SIMONDS.

A monster locomotive, which was built at the Altoona, Pa., shops of the Pennsylvania Railroad, made her initial trip, April 25, from Broad street, Philadelphia, to West Chester, in charge of the veteran engineer, Andrew Chambers. The engine weighs 120,400 pounds. The driving wheels are five feet and the truck wheels thirty-three inches in diameter. The engine is known as a "double ender," and is said to be the largest locomotive in the world. On her trip from Altoona to Philadelphia she made a mile in fifty-nine seconds.

TO SOLDER CAST IRON. — Soldering cast iron is generally considered to be very difficult, but it seems to be only a question of thoroughly brightening the surface to be soldered, and using a good solder and a clean swab with muriatic acid. Sodium amalgam might be usefully employed for the purpose.

The secretary of the American Society of Mechanical Engineers, in accordance with the instructions given him at the last meeting, is sending out for signatures, copies of a memorial to Congress asking the appointment of another Commission to test iron and other structural materials. It embodies the points presented in the address of Prof. Egleston, (which appears on the opposite page). Copies may be had by applying to the Secretary, T. W. Rae, 239 Broadway, New York.

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NEW YORK, MAY 13, 1882.

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The Philadelphia Meeting of the American Society of Mechanical Engineers.

The recent meeting of the American Society of Mechanical Engineers at Philadelphia was undoubtedly the most important one yet held by the society, the good attendance and general attention to the business in hand attesting to the interest of the members in the proceedings. A large number of important papers were read and discussed, the only difficulty in this respect being a lack of sufficient time to devote to this purpose, it being necessary to cut the discussions short in many instances, while in others papers were passed without discussion, and still others read only by title. Coupled with the more substantial benefits of this meeting will be the remembrance of the manner in which the society, as a body, and the members, individually, were received and welcomed by the citizens of Philadelphia. In regard to this, it is unnecessary to say more than that the manner and spirit of the welcome was perfect, and, as we happen to know, was fully appreciated.

Perhaps one of the most noteworthy things in connection with the meeting, the importance of which is our excuse for briefly referring to it, was the entire unanimity of expression in reference to the advisability of re-establishing the Government Commission to test iron, steel, and other metals and materials used in construction.

It is in every way unfortunate that this commission was allowed to go out of existance, and we believe, as expressed by the society, that the best interests of the country demand that no time shall be lost in its re-establishment, and in getting it in such a condition that the multitude of our industries may be benefited by its labors. There should be no difficulty in this, since it is plain to those who give the matter a slight consideration that the benefits to be derived from the experimental investigations of such a commission must be more evenly distributed than is usually the case. In fact it is difficult to see how an argument that it is in any sense a class measure can be entertained. This is fortunate as having the probable effect to disarm in advance, all hostility to the measure.

We have in this country the ores and fuel in abundance, but that the products into which constructive materials enter, may be cheapened to every one, and that safety may result from their use, it is absolutely necessary that we increase our knowledge of their physical properties and the effect of the various combinations of matter and forms. It must be admitted that our knowledge in this respect is remarkably defective, and that in some way it should be increased. Such tests of materials as have been made, and the data of which make up the knowledge of the engineer and the manufacturer on this subject, lack most of the essentials of completeness. Always entirely inadequate for ordinary purposes, the distance between them and what is really needed, is further widened by the character of present demands.

What is needed is the records of tests and investigations by the Government, and in the interests of the whole country, not for the benefit of manufacturers, further than incidentally, but to the end that every citizen shall not, in paying an increased price for what he buys, and in increased taxes, pay as he has to do for costly and constant mistakes that will never cease, until they cease by virtue of a better understanding of the properties and behavior of materials used in construction.

What is wanted is not a little information covered up with a multitude of patents, or hidden as a trade secret, but a comprehensive knowledge, free to all, which shall cheapen what we buy, add to the general comfort and make every railroad or steamship passage, every bridge crossed or structure erected safer. We need so far as possible to be rid of the uncertainty that brings about extravagant and costly use of materials, and sometimes the construction of a constant menace to life and property.

The facts as set forth in the report of the committee of the society on such tests, and in the discussion that followed, are so plain to all, being only more patent to engineers and manufacturers because they are brought more directly in contact with them, that no difficulty should be experienced in bringing about the desired end.

One of the first steps towards a competition with other countries in manufacture is a better knowledge of how to economically use the materials that naturally come to our hands, and if the American Society of Mechanical Engineers shall do anything to the accomplishment of this end, it will be to their credit, and to the advantage of the whole country.

Thursday the members of the Society, together with several ladies and gentlemen of Philadelphia, were treated to an excursion down the river on the propeller "Wilmington." This was in every way an enjoyable affair, the committee who had the matter in charge having made every provision for the pleasure of their guests, including a collation on board the boat. A stop was made at the shipyard of William Cramp & Sons, where the excursionists were met by members of the firm and others in attendance, and escorted through the works, witnessing some of the operations of iron shipbuilding, and inspecting the vessels on the stocks in various stages of the processes of construction.

Another stop was made at the shipyard of John Roach & Son, and after a brief inspection of the works the party returned to Philadelphia, where delegations visited the shops of the Baldwin Locomotive Works, William Sellers & Co., The Southwark Foundry & Machine Co., Whitney & Son, Riehle & Co., the Fairbanks Scale Store Rooms, and other manufactories.

While several members of the Society of Mechanical Engineers were visiting one of the large manufacturing establishments of Philadelphia, one of those trifling accidents against which no foresight can guard compelled the stopping of the machinery for a few minutes. Immediately a philosophical member deduced the fact that, from the number of workmen employed, every minute the machinery was stopped represented a loss to the firm of a day's time of a single individual. It is to be presumed he calculated that the company should receive five dollars for the individual's day's work, upon which hypothesis he argued them out of about one hundred dollars.

At the Southwark Foundry and Machine Co.'s shops are some heavy English planers, that, contrary to the usual practice in this country, are provided with flat ways and slides. Side motion of the table is prevented by flat surfaces at the inside of the platen slides, working against adjustable gibs. An excellent arrangement for oiling the slides consists of rolls of two diameters situated in oil chambers in the bed. These rolls are held in contact with the slide by springs, the smaller diameter and a larger part of the roll being in contact with the platen slides, the motion of which causes the roll to revolve. The larger diameter, which is simply a flange, in revolving carries the oil up from the chamber and distributes it on the small part of the roll, and also lubricates the side bearing. These planers are severely plain as compared with most American tools, looking in some of their parts as if special pains had been taken to make them ugly.

A vertical two-spindle English boring machine, used for boring the boxes of connecting rods in place and at one setting, is architecturally much better looking than the planers.

A correspondent, a manufacturer, who requests us not to use his name, writes us in commendation of the agitation on the pipe tap and pipe taper question. He suggests that there is difficulty in the way of size of pipe threads as well as the taper, and the much abused plumbers and pipe fitters have to shoulder the blame that ought to attach to the manufacturers who do not follow any standard, if there is one. There is too much truth in our correspondent's strictures, and we agree with him that something should be done in the way of bringing around standard work. It is impracticable, or impossible to avoid mixing the work of different manufacturers, and this work should undoubtedly conform to some universal standard.

A Point or Two on Mechanical Drawing.

At the Baldwin Locomotive Works, Philadelphia, the plan was some years since adopted of making all working drawings to a uniform scale of two inches to the foot. Undoubtedly this particular scale was adopted for sufficient reasons, but a reason is given for the use of some uniform scale that perhaps may not have occurred to every one. That is that the habit of looking at drawings of the different parts of a machine that are always of the same proportionate dimensions, as compared with the parts as constructed, educates the eye so it is possible to judge of the effect on the general appearance of a machine of the addition of some part, as well as if the drawing was full size. In other words the machine in all its parts at the reduced scale, is in the "mind's eye" of the designer and draughtsman, instead of those parts at different scales which he must mentally reduce to a common scale, to judge of the effect of their combination.

Draughtsmen are at times more or less puzzled by this, and it is said—and no doubt truly—that the result of constantly working on a single scale effectually overcomes all difficulties in this respect.

The scale used is in no way troublesome to the workmen, since all dimensions are plainly marked, making it unnecessary for him to do any measuring. In fact, the adoption of a scale not so readily measured with an ordinary rule is undoubtedly an advantage, as tending to do away with the altogether natural habit workmen sometimes have of measuring scale drawings in preference to reading the dimensions marked on them.

Another point of considerable importance, is the fact that there is no necessity for having different drawing scales lying around the drawing room, special scales being in all cases used. This, as every draughtsman knows, saves time that is lost in picking up the wrong scale when looking for the right one, and also saves the mistake, sometimes, of using the wrong scale.

The drawings are made on different sizes of special card board, drawing boards being used having grooves in which the card board is slid, the surface being flush with the surface of the drawing board and leaving no obstructions in the way of sliding the T square over it. The drawings are varnished when completed, and should it at any time be necessary to make alterations in some of the parts, the application of alcohol to the part removes the varnish, when the desired change can be made, and the part be again varnished.

The *beginning* of the drawings are the specifications which, following a thoroughly systematized course, appear as working drawings. To add to the general completeness the drawing room is large, pleasantly located, and *fire proof*.

A Sunbury, Pa., correspondent writes us: "W. F. Beardsley, M. M. Sunbury Shop (P & E Div.), has resigned and accepted a similar position in the Pennsylvania Co.'s shops at Wellsville, Ohio. A. Dolbeer, foreman of the machine shop has been appointed foreman of the machine shop at Renovo, Pa., succeeding Henry K. Stout, who has been appointed M. M. of the Sunbury shop. The men have contributed liberally to the purchase of testimonials of their regard for their retiring officers, purchasing for Mr. Beardsley a silver service of five pieces costing $135 and a gold watch for Mr. Dolbeer, costing $85. These presents are particularly valuable as being the spontaneous and voluntary offering of the men. They constitute an evidence of the high regard and appreciation existing in the minds of the men for these two officers who are certainly capable and efficient.

Literary Notes.

THE UNIVERSAL CALCULATOR, containing complete and simple instructions for performing all business calculations, as well as those constantly needed by mechanics and artisans, with marvelous accuracy and dispatch. Price $1.00. Published by W. H. Wythe, Red Bank, N. J.

This book of instruction is accompanied by an instrument consisting of four circles drawn upon heavy card board. 11″ x 12″ in size.

These circles form four concentric circular scales, arranged in connection with two movable German silver arms pivoted to the center of the circle, so that their edges may be readily set to coincide with any of the figures upon the scales. The two outer scales only are used in ordinary arithmetic, while the two inner scales are marked sines and tangents and are used only for calculations in Trigonometry. One of the arms is attached to a disc of card board and moves with it, while the other may be adjusted independently and is held by a clamp to the edge of the disc, so that when once set the two arms move together maintaining the relative distance between the two arms.

If one arm be set at 1 on the scale, and the other at 2, and the arms then moved by the disc until the first comes to 2, it will be seen that the other will stand at 4 and so on, the proportion remaining constant however the arms are moved. The rule for using the calculator may be briefly stated as follows. As any number at the first arm is to any number at the second arm (and the arms move together), so is any other number at the first arm, to the number at the second arm. It will be understood from the foregoing that any problem in the rule of three or simple proportion may be solved by the calculator. It is also capable of being used similar to the engineers' slide rule and it is claimed with greater precision.

Questions & Answers.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common sense methods.

(157) Will you please tell me a suitable taper for small reamers for dowel pins? *A.* ⅛″ to the foot answers very well.

(158) C. S. S., Milwaukee, Wis., asks; Will you tell me if it is practicable to run a rotary valve on a small steam engine by gearing? *A.* Yes.

(159) A. A., Calais, Me., asks: 1. How would a coupling to connect steam radiators between cars be received? *A.* Probably well if better than anything at present in use. 2. Are there any in use? *A.* Yes, several varieties.

(160) J. K. F., Detroit, Mich., asks: Can a sprung planer bed and cut ways be adjusted sufficiently accurate for practical purposes without replaning? *A.* We think it would be difficult to make a satisfactory job of it.

(161) W. S., Grand Rapids, Mich., asks: 1. Can you tell me how to harden copper plate? *A.* Copper plate can be hardened by rolling, by hammering, or by submitting to a heavy pressure. 2. How can I make brass plate soft? *A.* Heat to a cherry red and plunge in water.

(162) E. F. L., Lancaster, Pa., writes: We are having trouble with the tuyeres in our blacksmith fires. They burn out very rapidly. They are set 1½″ to 2″ below level of hearth. I think they would stand better if set 4″ to 4½″ below. Am I right? *A.* We do not know what forges you are using, but on general principles we think you are right.

(163) W. W. R., Macon, Ga., asks: At what speed should a smooth iron disc be run to cut iron and steel? *A.* Henry Disston & Sons, Philadelphia, of whom we inquired, courteously reply as follows: "In common practice *now*, discs for cutting iron and steel (say 40 to 44 inches diameter) are run from 55,000 to 65,000 feet on the periphery per minute. 20,000 to 25,000 feet per minute used to be considered ample. Some parties in England have run them 80,000 to 85,000 feet, so we are informed."

(164) R. M. P., Savannah, Ga., asks: Can you tell me how to tin chaplets, anchors, etc.? *A.* You must first remove the scale so as to get a clean surface. If of cast iron this can be done on an emery wheel. If of wrought iron they can be ground clean, or immersed in a solution of sulphuric acid and water, then scoured and washed with pure water. Then heat hot enough to melt tin, sprinkle over with sal-ammoniac and apply the tin, wiping off the surplus. If doing in large quantities the tin can be melted in a pot, and the pieces dipped in the melted tin.

(165) F. N., Youngstown, Ohio, writes: I wish to drive a machine 3,000 revolutions per minute, from a shaft running 45 revolutions. There will be two intermediate shafts between the main shaft and the machine. How shall I calculate the diameters of pulleys for this? *A.* You should calculate on losing about 8 per cent. of speed by slip of belts, or say 240 revolutions. Add this to the proposed speed and calculate the pulleys as if you were to run 3,240 revolutions. As you do not seem to have fixed upon the size of any pulley, the best way is to assume such sizes as appear most convenient, determine the speed you will get from the combination, and if necessary change the assumed size of one or more of the pulleys till your speed is right. With any known diameter of pulleys, to find the speed the machine will run; multiply the number of revolutions per minute of the driving shaft and the diameters of the *driving* pulleys together; then multiply the diameters of all the *driven* pulleys together, and divide the former by the latter. Assume that you have a 12 foot pulley on the main shaft belting to a 4 foot pulley on the second shaft. On the second shaft an 8 foot pulley belting to a 2 foot pulley on the third shaft. On this shaft a 3 foot pulley belting to an 8″ pulley on the machine. The driving pulleys are 12, 8 and 3 feet, and the driven are 3 feet, 2 feet and 8″, or ⅔ of a foot. Multiply together and 45×12×8×3=12,960, and 3×2×⅔=4. Then 12,960 divided by 4 equals 3,240 which is the correct speed. These sizes of pulleys may be changed to suit circumstances, determining the results as above. More direct means of determining the sizes may be employed, but this method is simple and easily understood.

Business Specials.

Transient Advertisements, 50 cts. a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday morning for the ensuing week's issue.

We receive numerous inquiries relating specially to matters of private interest. While desirous to oblige our friends, we would suggest, that an advertisement of two or three lines under this heading will usually develop the desired information easily and quickly.

Portable Forges, $10. Holt M'fg Co., Cleveland, O.

Presses & Dies. Ferracute Mach. Co., Bridgeton, N.J.

James W. See, Consulting Engineer, Hamilton, O.

Presses and Dies. Ayar Mach. Works, Salem, N. J.

Latest and best books on Steam Engineering. Send stamp for Catalogue. F. Keppy, Bridgeport, Ct.

Foot Power Machinery, for workshop use, sent on trial if desired. W. F. & John Barnes, Rockford, Ill.

J. C. Hoadley, Engineer and Expert, 29 High St., cor. Federal, Boston, Mass.

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

Do you manufacture Hardware or House furnishing goods you wish sold in New York? If so, address Manufacturer's Agent, care of AM. MACHINIST.

For Sale—One Richard's Indicator, nickel-plated and in good order. Address, H. L. Butler, E. High street, Germantown, Philadelphia.

Machinists' Bench Tools; largest stock in the United States. Send for Machinist Catalogue, 212 pages. Tallman & McFadden, 607 Market st., Philadelphia.

"How to Keep Boilers Clean," and other useful information for steam users and engineers. Book sent free by the publisher, Jas. F. Hotchkiss, 84 John Street, New York. Mention this paper.

J. E. Kelley, New Haven, Conn., a roofer of long experience, writes to T. New, 32 John street, N. Y.: Your process for manufacturing Prepared Roofing is perfect, giving entire satisfaction.

"Slide Valve Gears," by Hugo Bilgram, published by E. Claxton & Co., Phila., describes the easiest method known for correctly proportioning slide valves, link-motions and cut-off gears; price, $1.00.

Russell & Struthers, Wax Process for making outline engravings. Specimens each week in the AMERICAN MACHINIST. We also do Map Engraving with best facilities. Russell & Struthers, 59 Park Place, New York.

"Steam Economy," by Alfred Wilkinson, M. E., 123 N. 4th St., Philadelphia. Tells how to use the indicator. Points out and remedies defects in Steam Engines. Illustrated with numerous diagrams. Great variety of practical information for steam users. 124 pp., cloth, $1.00 by mail.

If you desire to keep pace with the daily progress and development of Telephone, Telegraph and Electrical matters, have a copy of the NEW YORK REVIEW OF THE TELEGRAPH AND TELEPHONE, sent to your address. Only $2.00 per annum. George Worthington, Editor and Proprietor, No. 23 Park Row, New York. P. O. Box 3329.

Machinery for Sale.—All in good condition, and some of it quite equal to new. Ames' Engine Lathe, 13 in. swing, 6 ft. bed; Prentice Foot Lathe, 16 in. swing, 4 ft. bed; Pratt & Whitney Hand Miller; Stiles' Power Punching Press, 400 lbs. Flywheel; Leach Shears; Wire Straightener. S. McHenry, 927 Filbert st., Philadelphia.

"Sibley College of Mechanic Arts, Cornell University.—Entrance examinations will be held June 12th and September 11th, 1882. For the register and catalogue just issued, containing reorganized courses of instruction, scientific and practical, including draughting, machine construction, general shop work, etc., apply to the President of Cornell University, Ithaca, N. Y."

Bound Volumes and Patent Binders. We can furnish Volume 3 of the AMERICAN MACHINIST, containing the full 52 issues of 1880, or Volume 4, containing the 53 issues of 1881, neatly bound in cloth, ready to ship by express, for four dollars. Either volume unbound, three dollars. "Patent Binder" for the AMERICAN MACHINIST holds 53 weekly issues in good shape. Sent to any address by mail for one dollar. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton Street, New York.

Ealy's "Blue Book,"—Special classified list of Machinists, Machinery, Railway, Engine and Boiler Makers supplies, etc., with financial standing and paying qualities of all dealers and manufacturers. Much more convenient and reliable than any other work of the kind published. We also furnish full detailed written reports. Trial rate to July 1, 1882. The JOHN W. EALY COMPANY, 51 Chambers street, New York or 79 Dearborn street, Chicago, Ill.

Cumberland-Blossburgh Coal; the best blacksmith coal in the United States. Free from sulphur and earthy matter. Never clinks; forms a perfect weld. Shipped to all points west by C. C. & E. M. Johnson, Room 21, Coal Exchange, Pittsburgh, Pa.

"Extracts from Chordal's Letters," the most interesting mechanical book published. A great variety of mechanical and business topics treated in a wise and witty way that will be instructive to old and young mechanics, and interesting to everybody. As many as 150 copies have been sold in a single shop. Over 40 Humorous illustrations; 320 pages, 12 mo. Price, $1.50 per copy, by mail, to any address. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton St., New York.

Manufactures.

There is a good demand for saw-mill machinery in most parts of the South.

The Sandy Hill, N.Y., Iron and Brass Works have commenced a new foundry building.

Carter & Stevenson, of St. Louis, have leased the Lynchburg, Va., Iron Works for a term of years. The works include foundry and machine shops.

Oliver Bros. & Phillips, Pittsburgh, Pa., have just completed a new foundry 80x50 feet. It is well equipped.

Massillon, O., has donated $6,000 and 1½ acres of land to a new glass works about to be started in that city.

The new shop of Coleman & Comings is at Middletown, N. Y., not in Connecticut as we had it in a late issue.

The new Indianapolis Car Works, Indianapolis, Ind., now employ 592 men and are turning out 12 freight cars and 108 car wheels a day.

Frank Curtin, Gloversville, N.Y., employs usually about 16 hands in manufacturing small power engines and sewing machines. He complains that machinists are very scarce in that village.

John Roach has over 2,000 men employed at Chester, Pa., on 13 vessels representing an aggregate tonnage of 27,000 tons. He has built over 100 vessels in eleven years, costing in all $25,000,000.

At Lowell, Mass., Cole & Nichols are to build on an extension to their foundry the present season. The extension will be 46 by 100 feet, and will give them when completed, a structure 170 by 70 feet.

The erection of a very complete machine shop, with a heavy steam hammer, will increase the force of hands employed by the Bass Foundry and Machine Company, at Fort Wayne, Ind., to 800 men.

Samuel P. Hedges recently purchased a piece of property in Greenport, N, Y., for $3,000, on which to erect machine shops. Work on the first building has been begun. It is to be 38 by 75 feet.

The Edgar Thompson Steel Works, it is stated, have purchased nearly all the mill cinder on disposal in Pittsburgh. They propose to use it in manufacturing steel by the basic process.

The Bridge-Beach Manufacturing Company, of St. Louis, Mo., is building a 239x80 foot brick addition for the purpose of enlarging its moulding-room department.

The Defiance Machine Works, at Defiance, Ohio, propose building this Spring a brick machine shop, three stories and basement in height and 66x132 feet. At present 125 men are employed.

Wilson and Shugart, engineers and machinists, formerly with the American Machine Company, have opened an establishment at 314 Green st., Philadelphia, for the manufacture of machine tools.

Curtis & Co., St. Louis, Mo., will soon begin the erection of extensive factory buildings on three blocks of ground on the river front. They will include saw works and an extensive general machine shop.

The Knowles Steam Pump Works, 86 Liberty street, New York, and 44 Washington street, Boston, have issued a new catalogue in the finest style of typographic art. It contains a number of fine wood engravings. The cover is in the most approved æsthetic taste.

The Ferracute Machine Co., Bridgeton, N. J., has just issued a revised price list on one sheet, describing (with cuts) a complete outfit of can-maker's tools, all that are required for meat, fish, fruit and vegetable cans. It appears from this circular, that an outfit of tools for a can factory running four or five men, and making 1, 2 and 3 pound fruit and vegetable cans (about 3,000 a day) costs only $415. For ambitious mechanics and others who have saved a little money, the business of making cans, seems to be a good one. The Ferracute Co., has sold hundreds of these outfits within the last two or three years. The circular will be mailed to any one who asks for it.

In a recent issue of the *Iron Trade Circular* of Birmingham, England, we find the following: "Trade in the local engineering branch would seem to be very active just now; and in order to meet the great inrush of orders lately experienced for steam engines, boilers, pumping machinery, and machine tools, Messrs. Tangye are under the necessity of again extending their works. The demand, which runs largely upon engines and machine tools, is chiefly for Mexico, South America, Australia, Russia, and France. The magnitude of the orders from Mexico and the South is especially satisfactory, in view of Amrican competition and the activity of Yankee commercial agents in those markets. The new buildings now in course of erection for Messrs. Tangye are calculated to accommodate 500 additional workpeople.

A. Aller, of 109 Liberty Street, New York, writes us: There is a good demand being made now for Korting Condensers for steam engines. Have taken orders for six large condensers within the past ten days. We are also selling a great many Korting Double Tube Injectors, and our busines is continually increasing in all of Korting Steam Jet machinery. The outlook for 1882 bids fair to show double the sales of last year.

S. W. Putnam, who has been for 20 years connected with the Putnam Machine Company, of Fitchburg, Mass., has withdrawn from that company and is building new shops at Fitchburg. The business will be conducted under the name of the Putnam Tool Company, and will be for the manufacture of a general line of machine tools. The building at present to be erected is a shop 128 x 42 feet and three stories high, with a basement 42 x 63. Mr. Putnam has had a thoroughly practical experience in all the details of machine work and practice, from the work of an apprentice and journeyman in the shop, through the office and general management of the business, which will prove of great value in his new enterprise.

J. H. Morse and his son, F. H. Morse, have lately purchased the machine shop and tools complete, formerly owned by Dr. H. H. Hill, of Augusta, Me. The new firm propose to carry on a general machine repair shop, and will have full facilities for the manufacture of special machines, orders for which they propose to execute from inventors and patentees of new designs. The junior member of the firm has been foreman in the works of the Whittier Machine Co., Boston, Mass., and later has had charge of manufacturing a special machine in Boston for mining purposes. The business will be run under the firm name and style of F. H. Morse & Co., Augusta, Me.

The American Watch Tool Company, Waltham, Mass., of which Ambrose Webster is general manager, has been very busy during the past few months, and is engaged upon machinery for most of the leading watch and clock manufacturers in the United States and some foreign orders. They employ 60 workmen and turn out one jeweler's lathe every day. The principal business of this concern is to superintend the erection and equipment of watch factories. Among those already erected may be mentioned the Waterbury Watch Company's factory, Waterbury, Conn., which is said by competent judges to be one of the finest equipped in the world. It was built for a production of 1,000 watches per day.

E. P. Bullard, 14 Dey Street, New York, has quite recently purchased the buildings and property formerly occupied by the Bridgeport Lock Company, Bridgeport, Conn. The lot is 95 feet wide by 375 feet long, and fronts upon the railroad. The buildings are four stories high with basement, have a floor space of about 32,000 square feet and were erected by the lock company in 1875. The power is furnished by a steam engine and boiler of large capacity. Convenient out buildings adjoin the premises and advantages are offered for enlarging. A part of the building is now occupied by other manufacturing concerns, and Mr. Bullard has made use of several of the floors for the manufacture of machine tools during the past two years. He has now fitted up the premises for doing a general machine tool business, and will soon bring out a new planer.

The Southwark Foundry and machine Company, Philadelphia, Pa., have under way in their shops about 50 Porter-Allen high speed engines, from 25 to 1,500 horse power. They are also building a pair of large reversing engines for rolling-mill work, besides a variety of other machine work. This company is adding many heavy tools, some of them of English make. They are putting in an upright pulley boring and turning machine, from the Niles Tool Works, Cincinnati, Ohio, to which they are adding an extension to enable them to turn pulleys up to 26 feet in diameter. One large room of the works is fitted up with special tools and machinery and devoted to the manufacture of the governors used with their engines. Grant & Bogert, Flushing, L. I., are building a lathe to be used in this room for turning the peculiar shaped counterpoise or central weights of the governors. The erecting shops are arranged with a convenient system of cranes for handling heavy machinery, and a steam crane in the foundry expediates the handling of heavy castings, flasks, etc.

A comparatively new industry, that of copper spinning, has been introduced in Lawrence, Mass. As is well known, the old and familiar way of manufacturing vessels of copper and zinc has been by hammer, rivets and the soldering iron. A circular piece of sheet copper of ordinary thickness is placed on the lathe, and in a twinkling, without the use of hammers, shears, rivets or soldering iron is spun into the shape of a kettle, without a break or weakening of a single fiber of the material. There are no jointures, the kettle being formed entirely from the original circular copper sheet. The kettle breasts, sides, and a strengthening portion for the spout are formed of one piece of sheet copper metal and double-seamed to the pit, so that the seams are under the side of the kettle and forms a strengthening rib upon which it rests when in the stove. Ladles and other utensils in copper and zinc, cuspadores, etc., are formed in the same manner. When the kettle is spun from the lathe into shape, it is taken to the tinning room, where the interior is tinned. It afterwards goes to the buffing room and is polished, and thence to the plating room, where any desired plating is given. The works at Lawrence are the only kind this side of Connecticut, and are overrun with orders.—*Boston Commercial Bulletin.*

Machinists' and Engineers' Supplies.

New York, April 27, 1882.

The demand for machine tools continues good but during the past four weeks there has been a gradual decline in the demand for small tools, set screws, taps and dies, and other manufactured goods, orders are small. Manufacturers are busy.

The condition of the Pig Iron market remains quiet but firm in tone with transactions of a retail character. Both buyers and sellers maintain their conservative disposition.

We quote prices as follows: Foundry No. 1, $25 to $25.50; Foundry No. 2 X, $24 to 24.50; Grey Forge, $22 to $22.50; Foreign Iron is as a rule sold previous to arrival so that little finds its way to the stores. We quote: Gartsherrie, at $25 to $26; Coltness, $25 to $26; Glengarnock, $24 to 24.50; Carnbroe, $23.50 to $24; Englinton, $22.80 to $23; Somerville, $25: Steel and Iron Rails are fairly active. Copper is quiet at 18c. to 18⅛c., for Lake Superior; Banca Tin, 29c, Straits and Malacca, 23⅝c. to 22½c.; Billiton and Australian, 23c.; Lead, 5c.; Spelter Domestic, 5¼c.; Antimony, Hallett's, 12¼c. to 12½c.; Nevada, 12⅛c. to 12¾c.; Cookson's 14⅜c.

WANTED

"Situation and Help" Advertisements, 30 cents a line, each insertion. About seven words make a line. Copy should be sent to reach us not later than Thursday morning for the ensuing week's issue.

Foreman Pattern Maker wanted. Apply to Watts, Campbell & Co., Newark, N. J

Wanted—A situation by a Mechanical Draughtsman. Address A-N, Box 4, American Machinist.

Wanted—A thoroughly competent Mechanical Draughtsman. Address S. S. Hepworth & Co., cor. Eleventh Ave. and 27th St., New York City.

A practical Locomotive and Car draughtsman wishes a permanent situation. Address "Valve," care American Machinist.

Wanted—By a young man a position as foreman and draughtsman, now occupying a similar position. Address Comadore, care American Machinist.

Wanted—Practical Machinist with some capital and good references, to take interest in established paying business near Pittsburgh, Pa. Address, box 1, American Machinist office.

Wanted—American Foreman for Gray Iron Foundry. Heavy work. Address by mail C. T. Tyrrell, 9 Tribune Building, Chicago, Ill., stating class of work accustomed to.

The Ottawa Iron Works, Ferrysburg and Grand Haven, Michigan, want a few good machinists. Steady work and best wages. Reliable married men will find this a good opening.

Wanted—Practical Draughtsman, Machinist, or Foundryman with some capital and good references, to take interest in established paying business. Address L. M. Newbury, Sparta, Wis.

Wanted—Mechanical Draughtsman. One who is thoroughly posted on engine and pattern work. Address, giving references, etc. Smith, Myers & Schnier, 323 to 329 W. Front St., Cincinnati, Ohio.

A Practical Mechanic and draughtsman, now holding a leading position, will soon be at liberty. Best of references, including present employers. Address, "Mechanic," care J. B. H., 435 Washington street, Boston, Mass.

Wanted.—An experienced Traveling Man in the Injector business. One who thoroughly understands the trade, both practically and as a salesman. Give references and salary expected. Address, A. B., care American Machinist

A man 31 years of age desires a situation in a machine shop as superintendent or foreman. 13 years' experience as apprentice, journeyman, toolmaker, draughtsman and foreman in Illinois, Iowa, Minnesota, Nebraska, Kansas and Missouri. Correspondence invited from parties who mean business. J. E. McConnell, Iowa City, Iowa

COOKE & CO., Formerly Cooke & Beggs,
Dealers in MACHINERY AND SUPPLIES.
6 Cortlandt Street, New York.
AGENTS FOR
The Waters Perfect Governor,
Having Adjustable Speed, Automatic Safety Stop, Sawyer's Lever, and Solid Composition Valves and Seats.

ALSO,
SUPPLIES
For Machinists, Railways, Mills, Mines, &c.

Please send for circular and state that you saw the advertisement in this paper.

HOUGHTON'S BOILER & TUBE COMPOUND,
PURELY VEGETABLE.
LOOSENS SCALE & PREVENTS ITS FORMATION.
SAVES FUEL, LABOR AND REPAIRS,
HOUGHTON & CO.
16 Hudson and 130 Reade Sts., N. Y

BRADLEY'S CUSHIONED HAMMER
BRADLEY & COMPANY SYRACUSE N.Y.

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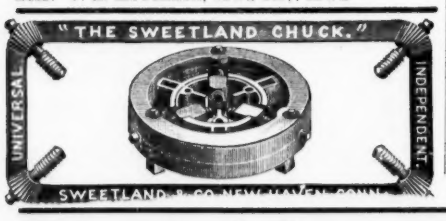

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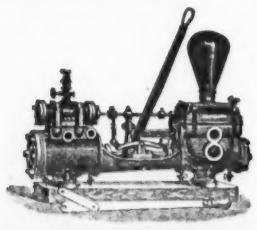

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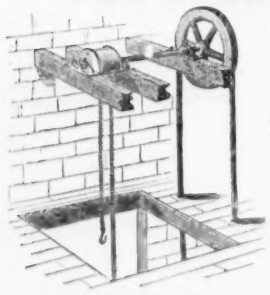

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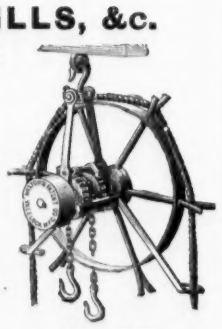

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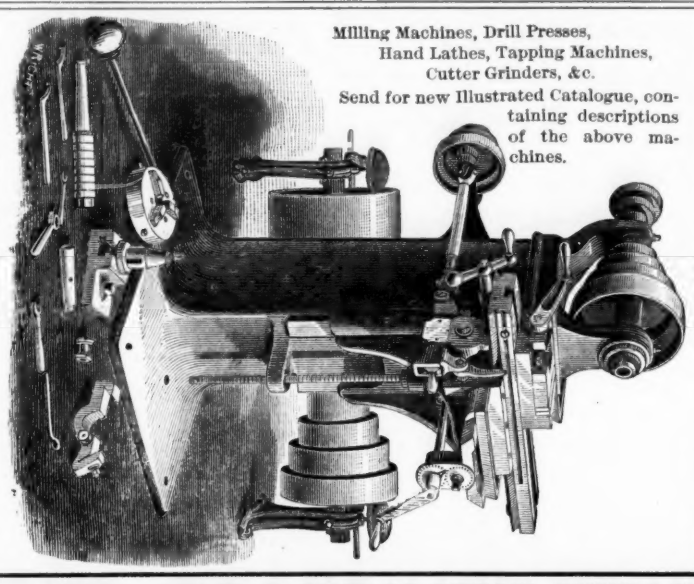

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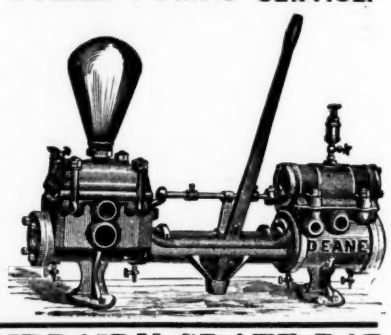

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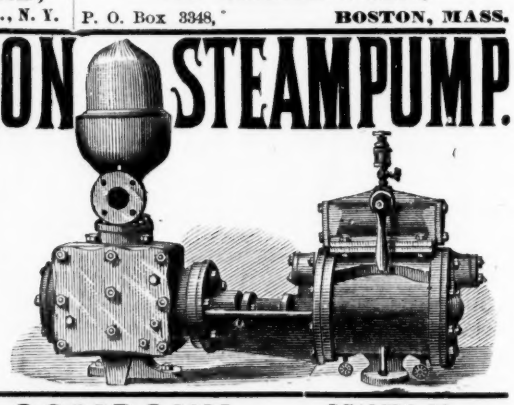

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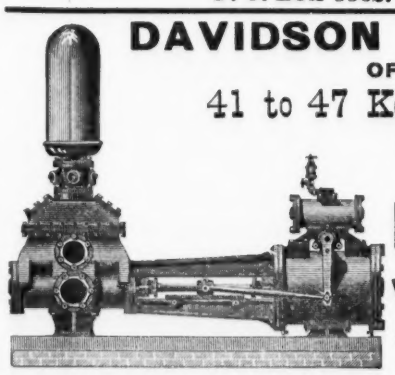

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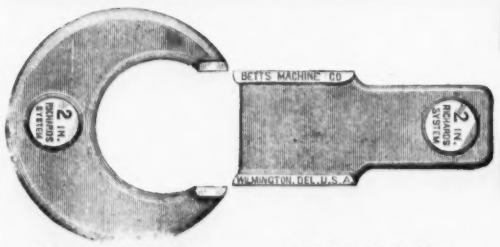

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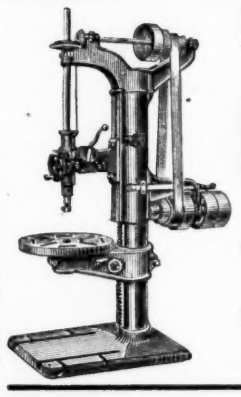

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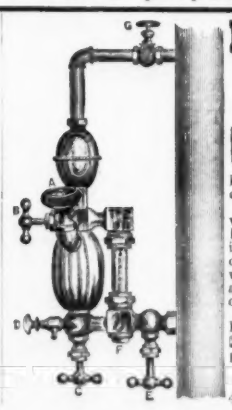

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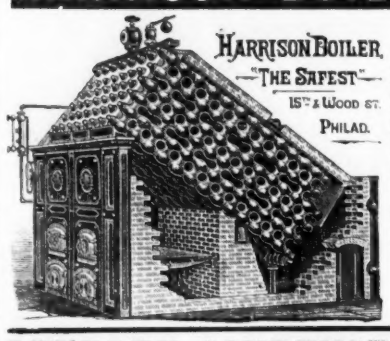

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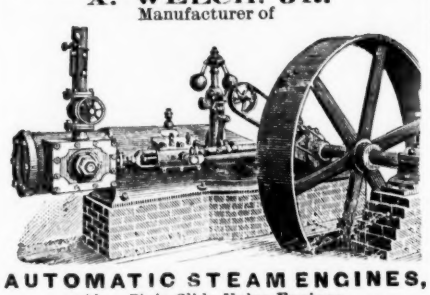

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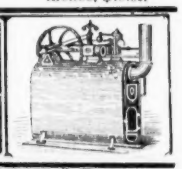

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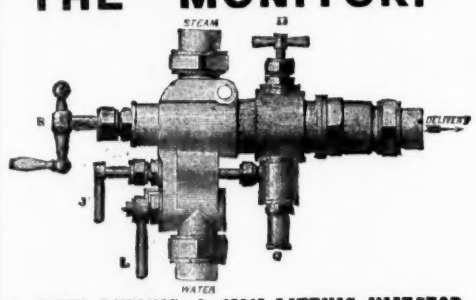

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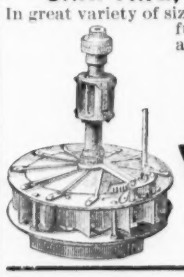

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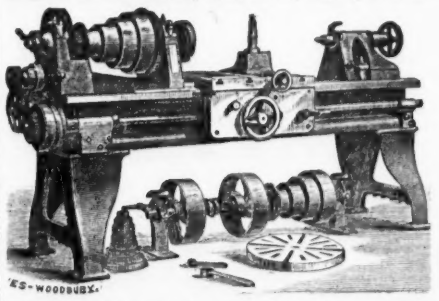

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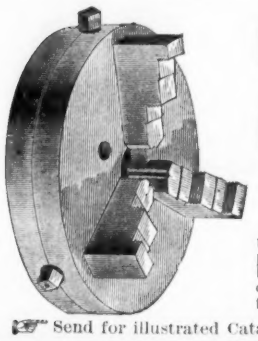

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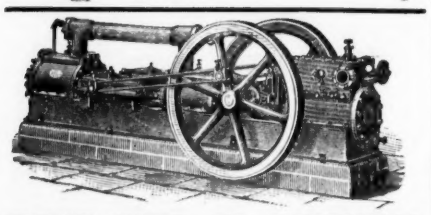

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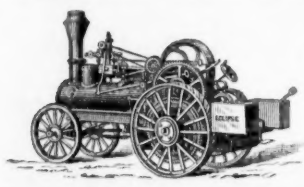

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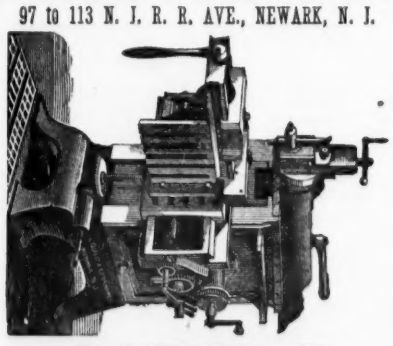

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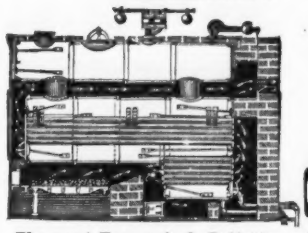

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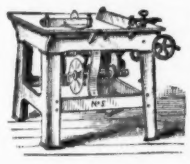

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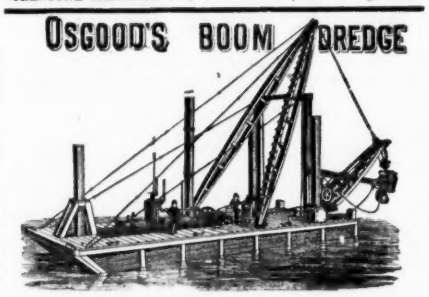

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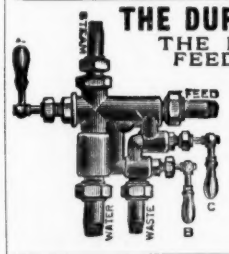

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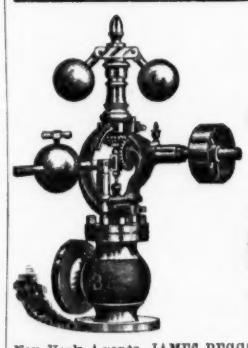

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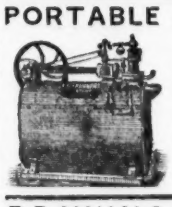

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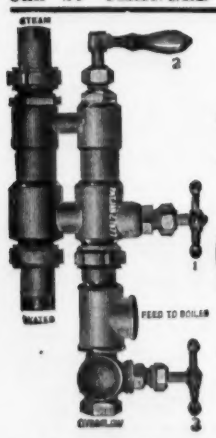

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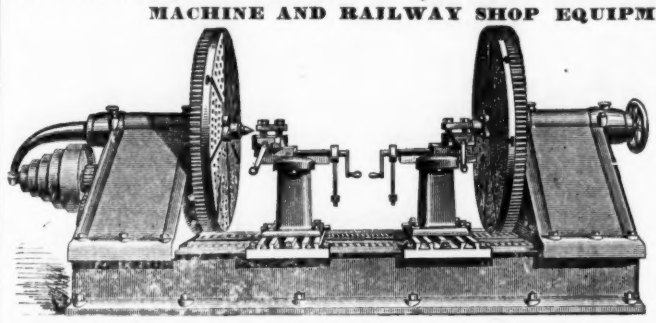

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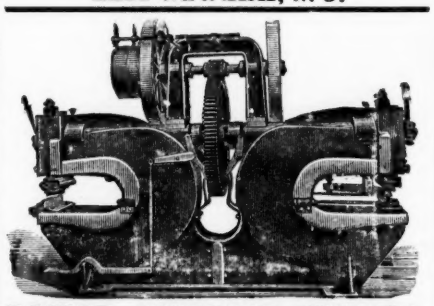

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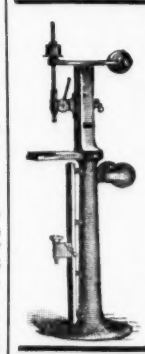

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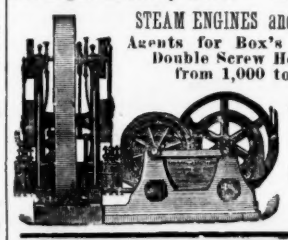

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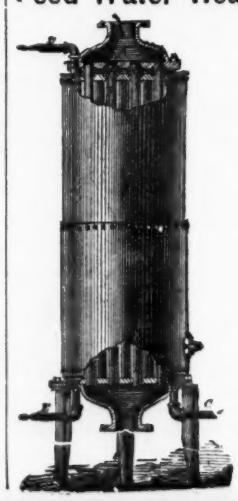

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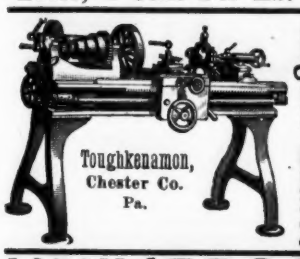

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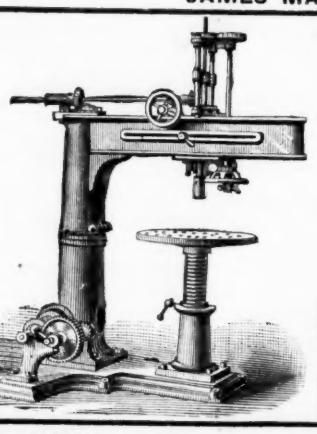

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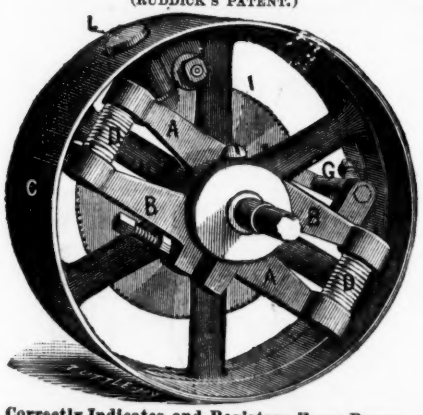

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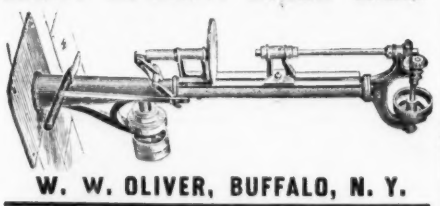

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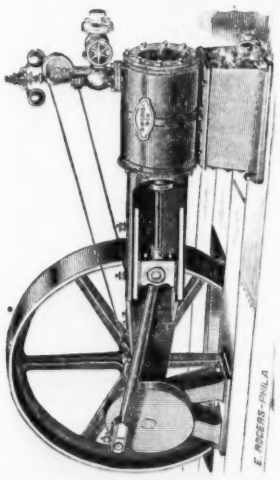

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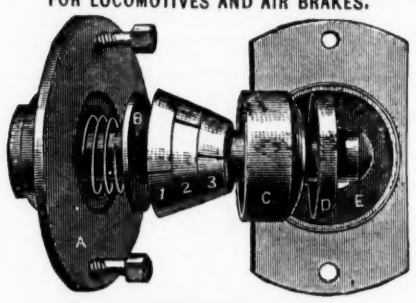

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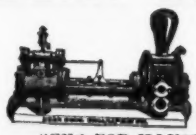

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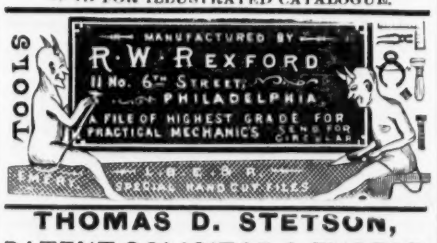

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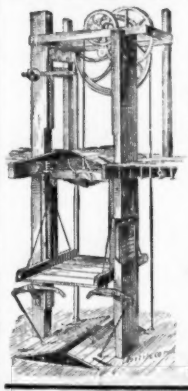

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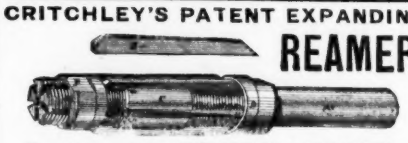

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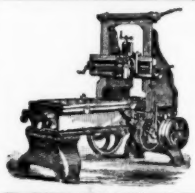

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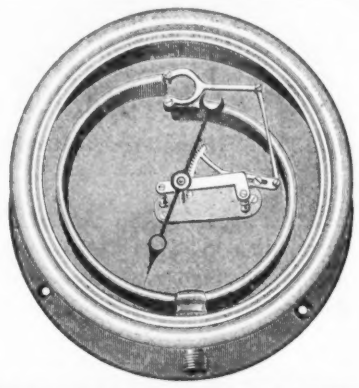

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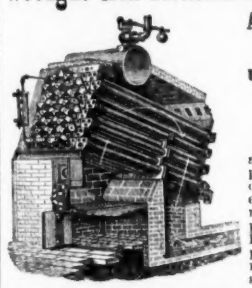

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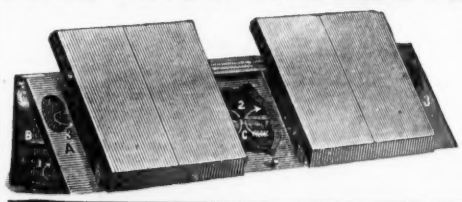

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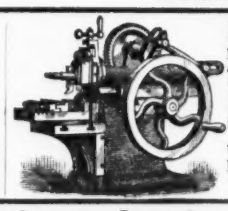

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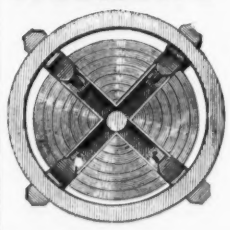

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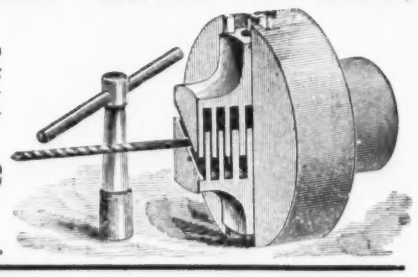

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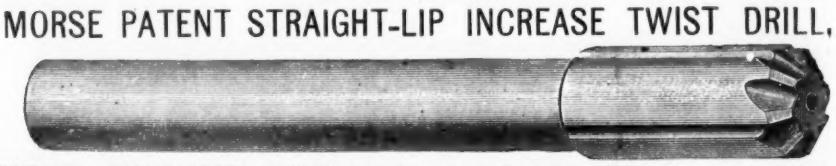

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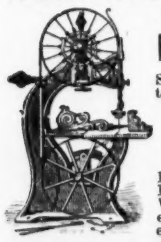

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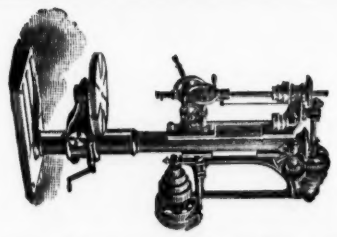

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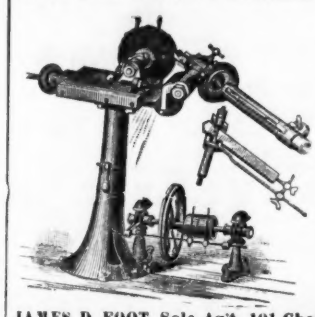

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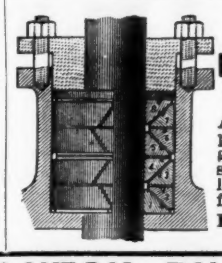

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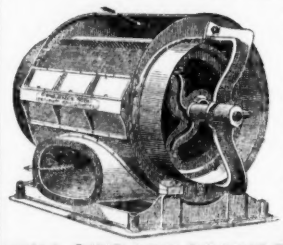

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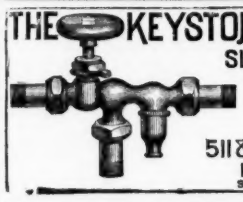

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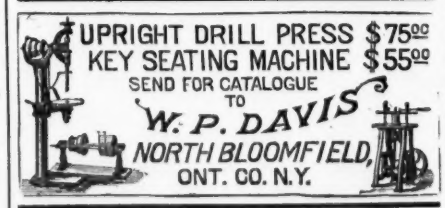

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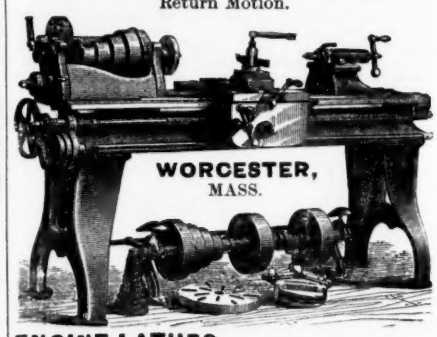

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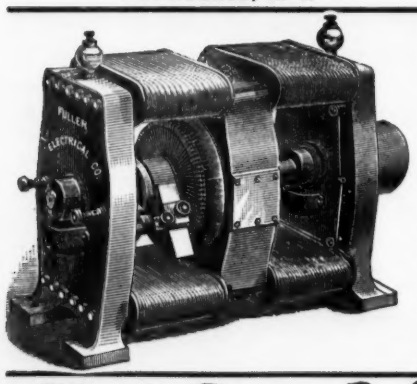

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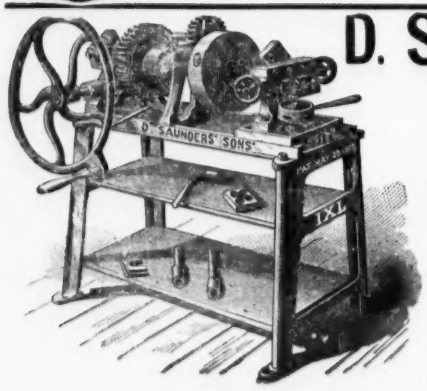

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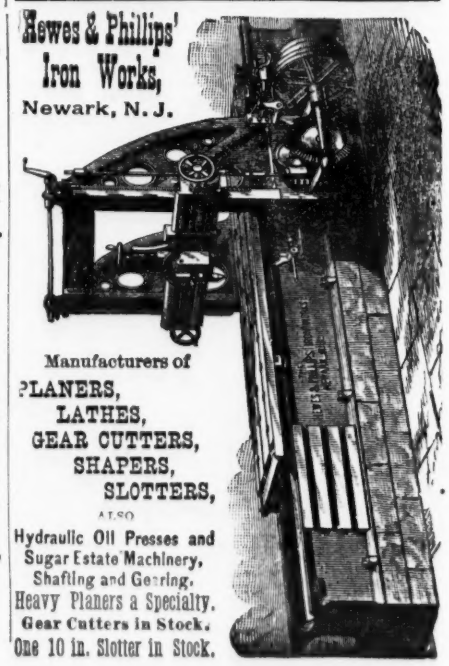

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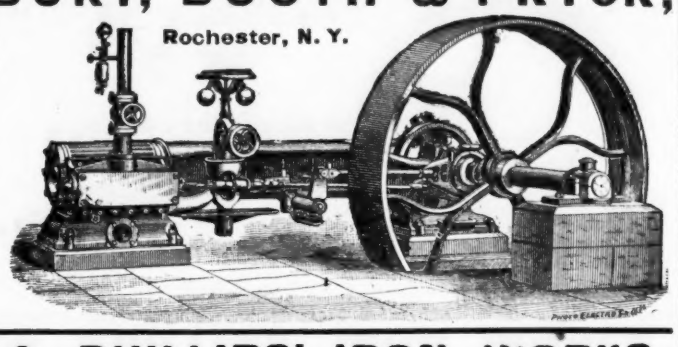

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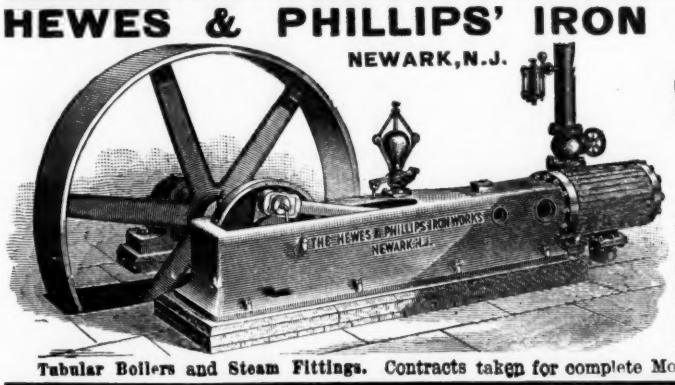

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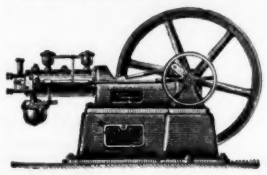

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1	" "	18 in. x 8 ft.	Lodge & Barker.	"
1	" "	24 in. x 12 ft.	Fifield.	"
1	" "	24 in. x 12 ft.	Fifield.	"
1	" "	20 in. x 12 ft.	"	"
1	" "	26 in. x 12 ft.	Lathe & Morse.	"
1	" "	30 in. x 16 ft.	Perkins.	"
1	" "	26 in. x 14 ft.	"	"
1	" "	16 in. x 6 ft.	"	"
1	" "	24 in. x 12 ft.	Michel.	"
2	" "	12 in. x 5 ft.	Young.	"
1	" "	12 in. x 5 ft.	Prentiss.	"
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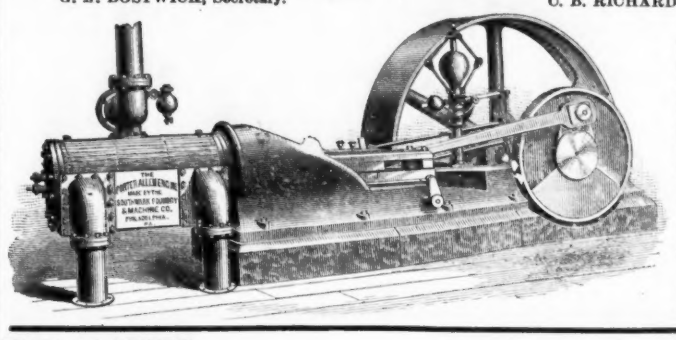

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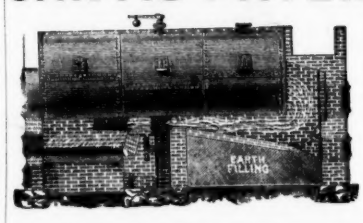

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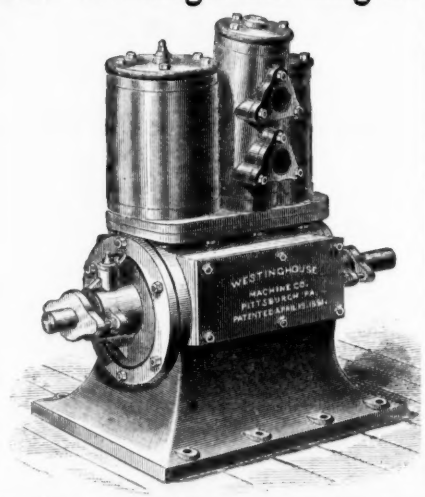

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The following New and Improved Machinists Tools are part of what we have for early delivery.

1	30 in. x 20 in. x 8 ft.	Planer.	New. May.
2	30 in. swing, 15 ft. bed.	Engine Lathes.	"
1	22 in. swing, 13½ ft.	Bed Engine Lathes.	"
5	22 in. x 12 ft.	Engine Lathes.	May.
3	19 in. swing, 10 ft.	Bed Engine Lathes.	May.
4	11 in. " 5 ft.	" "	"
2	30 in. "	Upright Back Geared Drills.	"
2	9 in.	Shapers.	New. May.
1	11 in.	Shaper, 25 in. Traverse.	May.

The following on hand:

1	30 in. swing, 15 ft.	Bed Engine Lathe.		New.
1	26 in. " 16 ft.	" "	"	"
2	19 in. " 8 ft.	" "	"	"
2	18 in. " 8 ft.	" "	"	"
1	18 in. " 8 ft.	" "	Tilting carriage	
1	18 in. " 11 ft.	" "	"	
1	17 in. " 6 ft.	" "		2d-hand.
1	12 in. " 4 ft.	" "		2d-hand.
1	12 in. " 4 ft.	" "		New.
1	15 in. " 9 ft.	Hand Lathe.		New.
3	12 in. " 6 ft,	" "	"	"
1	10 in. " 4½ ft.	Bed Hand Lathe.		New.
1	Boring Lathe, 16 ft. bed. 54 in swing.			
1	Round Arbor Fox Lathe. Fine order.			
1	30 in. x 30 in. x 8 ft.	Planer.		New.
1	26 in. x 6 ft.	Iron Planer.		2d-hand.
1	26 in. x 5 ft.	Iron Planer.		2d-hand.
1	20 in. x 4 ft.	"	"	
1	12 in.	Heavy Slotter.		New.
2	48 in.	Swing Radial Drills.		New.
2	38 in.	Swing Upright Drills.		B. G. & S. F. New.
1	26 in.	Drill.		B.G.&S.F. New.
1	18 in.	Bench Drill.		
1	2 Spindle Drill.			New.
1	4 "	"		"
2	Wall Drills, heavy.			Second-hand. 60 and 72 in
1	9 in. Shaper.			2d-hand.
1	Index Miller.			
2	Milling Machines, Lincoln pattern.			Second-hand
1	Manhattan Arms Co. Miller.			Second-hand
1	Sellers Milling Machine.			2d-hand.
1	Face Milling Machine.			Second-hand.
1	Pond's Double Milling Machine.			2d-hand.
1	No. 2 Screw Machine.			New. Turret Head.
1	Screw Head Slotter.			Second-hand.
3	Second-hand Profiling Machines.			
8	4½ in Hyde's Patent Centering Machines.			New.
1	Emery Grinder, 2d-hand, for 10 in. Wheels.			
1	Pipe Cutting Machine.			Second Hand. 2 in.
1	1 in. Wood & Light Bolt Cutter.			New.
1	Bolt Pointing Machine.			Second-hand.
1	Double Nut Tapper.			New.
1	Horizontal Boring Mill, 54 in. Swing.			
1	Horizontal Boring Machine, 10 in. Swing.			2d-hand.
1	Betts, No. 2, Power Punch.			New.
4	Double-Acting Presses, No. 3,			nearly new.
4	Single-Acting Presses, for power,			"
100	Foot Presses,			nearly new.
1	Medium Power Punching Press.			Second hand.
2	Small "	"	Presses.	"
1	Foot Punch, with bench.			New.
1	Lot Pistol Machinery.			Second-hand.
8	Grind Stones and Frames.			
1	Steam Hammer. Cylinder 6½x18.			2d-hand.

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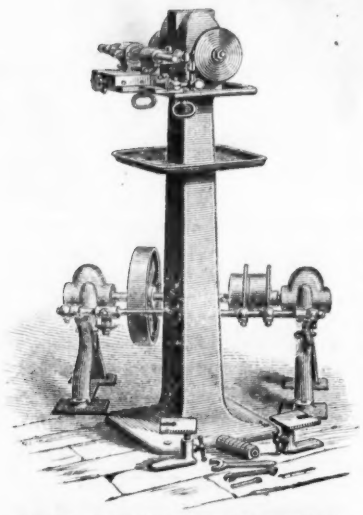

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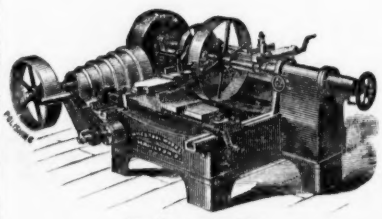
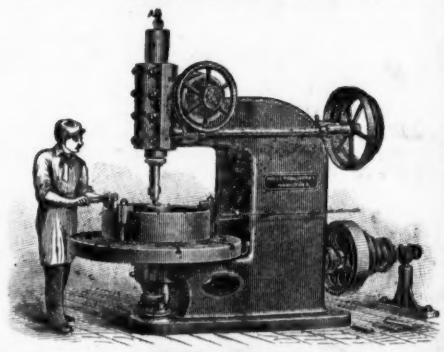


Pulley Lathe.



Pulley Borer.

REFERENCES.

Cram Bros. Manuf. Co., Chicago, Ills.; E. P. Allis & Co., Milwaukee, Wis.; Buckeye Engine Co., Salem, Ohio; Geiser Manufg. Co., Waynesboro, Pa.; Frick & Co., Waynesboro, Pa.; Pray Manufg. Co., Minneapolis, Minn.; North Star Iron Works, Minneapolis, Minn.; Grainger & Co., Louisville, Ky.; Blymyer Mfg. Co., Cincinnati, O.; Simpson & Gault, Cincinnati, O.; Poole & Hunt, Baltimore, Md.; Jones & Laughlins, Pittsburgh, Pa.; Sinker, Davis & Co., Indianapolis, Ind. M. C. Bullock, Chicago, Ills.; W. McGregor & Co., Chicago, Ills.

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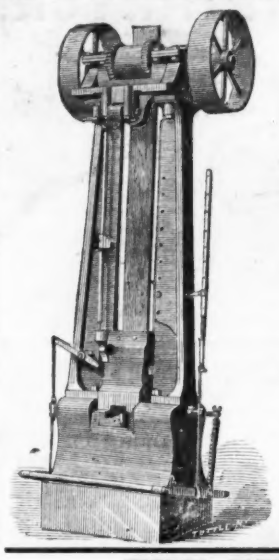

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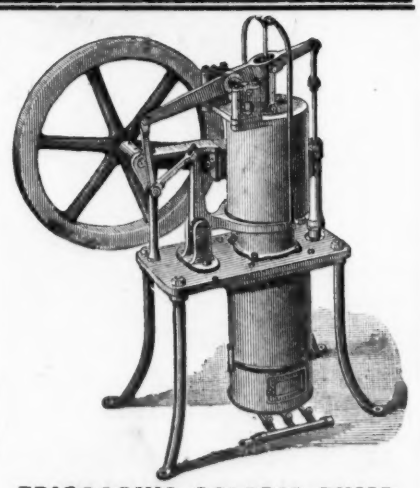

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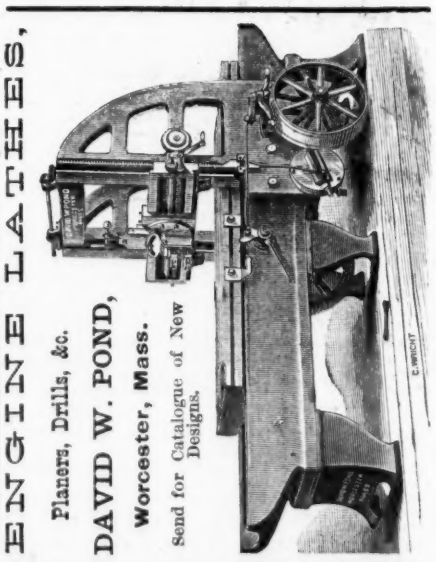

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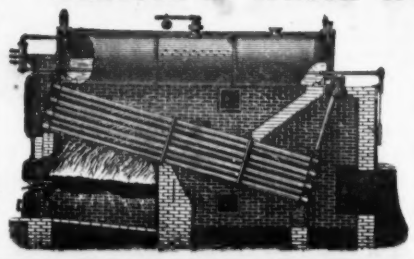

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